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Alabama Department of Transportation

2022

STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION

2022

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FOREWORD

This book has been prepared to provide a compilation of Standard Specifications for insertion by reference into Alabama Department of Transportation construction contracts.

U.S. Customary and Metric (SI) units of measurement are shown in this 2022 edition. Metric units of measurement are shown by the corresponding U.S. Customary units and are enclosed in braces { }. The units of measurement, either U.S. Customary or Metric, that are applicable to a construction project shall be those that are shown on the plans or in other contract documents.

The requirements given in these Specifications may be revised or amended by Special Provisions that are applicable to a specific contract.

Copies of this Standard Specifications book may be purchased from:

Alabama Department of Transportation
Office Engineer Assistant Bureau Chief, Plans and Proposals
1409 Coliseum Boulevard
Montgomery, Alabama 36130-3050

Book Number _____

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DIVISION 100
GENERAL PROVISIONS

SECTION 101
DEFINITION OF TERMS

101.01 Definitions.

Wherever the following terms or abbreviations (or pronouns in place of them) are used in these Specifications or in other contract documents, the intent and meaning shall be interpreted as follows:

(a) Abbreviations.

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ADEM	Alabama Department of Environmental Management
AGC	The Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ALDOT	Alabama Department of Transportation
ANSI	American National Standards Institute
ARA	American Railway Association
ARTBA	American Road and Transportation Builders Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
IMSA	International Municipal Signal Association, Inc.
ITE	Institute of Transportation Engineers
LPA	Local Public Agency
LVD	Laboratory Vibrated Density
MSDSAR	Materials, Sources, and Devices with Special Acceptance Requirements
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
SAE	Society of Automotive Engineers
SSPC	SSPC: The Society for Protective Coatings
UL	Underwriters' Laboratories, Inc.

(b) Terms.

Acceptance Plan. A prescribed method of sampling, measuring and testing together with criteria for the acceptability of a lot of material or construction.

Additive. A substance or agent added in small amounts to a basic ingredient of a mixture prior to mixing.

Advertisement For Bids or Notice to Contractors. A public announcement inviting bids for work to be performed or materials to be furnished, as required by law.

Area. A subdivision of a **Region** for the supervision of the **Department's** construction and maintenance operations.

Area Engineer. The engineer in charge of one of the Areas of the State.

Article. An immediate subheading of a section of these Specifications consisting of Subarticles, Items, Subitems and/or paragraphs which set forth details and requirements essential or necessary to form the Specifications. Specifications are divided into Divisions, Divisions into Sections, Sections into Articles, Articles into Subarticles, Items, Subitems and paragraphs.

Award. The acceptance by the Director of the proposal of the lowest responsible bidder, as required by law.

Backfill. Material used to replace or the act of replacing material removed during construction; also may denote material placed or the act of placing material adjacent to structures.

Back Slope. The sloping surface of a cut, of which the downward inclination is toward the roadbed.

Base. The layer or layers of specified materials of designed thickness placed on a subbase or a subgrade to support a pavement or surface.

Bidder. An individual, firm, partnership, corporation or any acceptable combination thereof submitting a bid for the advertised work.

Binder Layer. The lower layer of the surface, consisting of a plant mix of graded aggregate and bituminous material.

Bituminous Concrete. A designed combination of dense graded mineral aggregate filler and bituminous cement mixed in a central plant, laid and compacted while hot.

Borrow. Suitable material from sources outside the roadway prism, used primarily for embankments.

Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet {6.1 m} between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Engineer. The representative of the Chief Engineer of the Department that is responsible for the supervision of the structural design and analysis of all of the Department's transportation related structures.

Bridge Length. The length of a bridge structure is the over-all length measured along the line of survey stationing back to back of backwalls of abutments, if present; otherwise, end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Bridge Roadway Width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timber risers.

Bypass. An arterial highway that permits traffic to avoid part or all of an urban area.

Calendar Day. Every day shown on the calendar, beginning and ending at midnight, Sundays and holidays included.

Construction Change and/or Work Order Request. A written document between the Department and the FHWA covering proposed project changes.

Construction Joint. A joint made necessary by a prolonged interruption in the placing of concrete.

Construction Engineer. The representative of the Chief Engineer of the Department that is responsible for the general administration of the Department's contract construction work.

Contract. The written agreement between the State of Alabama and the Contractor setting forth the obligations of the parties hereunder for the performance of the prescribed work.

The Contract includes the proposal, contract forms and contract bonds, specifications, special provisions, general and detailed plans, and notice to proceed, also any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, and such other documents as by law or references are made a part thereof, all of which constitute one instrument.

Contract Bid Price. The sum total of the products of the approximate quantities of the items of the work listed in the proposal and the respective unit prices bid in the proposal.

Contract Bonds. The approved bonds furnished and executed by the Contractor and his surety to guarantee completion of the contract in accordance with its terms.

Contract Item. (Pay Item). A specifically described unit of work for which a price is provided in the contract. Each pay item is numbered and is paid for under the terms of the specification section of the same number.

Contract Payment Bond. The bond furnished by the Contractor and his surety to guarantee payment of the debts covered by the bond.

Contract Performance Bond. The bond furnished by the Contractor and his surety to guarantee performance of the work in accordance with the contract.

Contract Period or Contract Time. The number of work days or calendar days allowed for completion of the contract, including authorized time extensions.

In a case where a calendar date of completion is shown in the proposal, in lieu of the number of working or calendar days, such work contemplated shall be completed by that date.

Contract Sum or Contract Amount. The total contract bid price, revised to include changes caused by overruns and underruns in contract items, plus the sum of all approved supplemental agreements and force account orders.

Contraction Joint. A joint at the ends of a rigid slab to control the location of transverse cracking.

Contractor. The individual, partnership, firm, corporation, or any acceptable combination thereof contracting with the State for performance of prescribed work.

Controlling Item(s). The current controlling item(s) or operation(s) includes any feature of the work considered at the time by the Engineer as essential to the orderly completion of the work and which, if delayed, will delay the time of completion of the contract.

County. The county or counties of Alabama in which work herein specified is to be performed.

Culvert. Any structure not classified as a bridge which provides an opening under the roadway.

Dense Graded Aggregate. A well-graded aggregate so proportioned as to contain a relatively small percentage of voids.

Department. Alabama Department of Transportation, as constituted under the laws of Alabama for administration of highway work.

Detour. A route provided for traffic to use in lieu of a regular route.

Director. The chief executive officer of the Alabama Department of Transportation as created by law, also referred to herein as Transportation Director.

Divided Highway. A highway with separated roadways for travel in opposite directions.

Dowel. A load transfer element usually consisting of a plain round steel bar.

Drainage Plane. A plane for internal drainage of the roadbed, usually formed by a layer of water-permeable material.

Easement. A right to use or control the property of another for designated purposes.

Embankment. A structure of soil, soil-aggregate or broken rock between the embankment foundation and the subgrade.

Embankment Foundation. The material below the original ground surface the physical characteristics of which affect the support of the embankment.

Employee. Any person working on the project to which these specifications apply, and who is under the direction or control of, or receives compensation from, the Contractor or Subcontractor.

Engineer. A qualified Department staff member designated by the Director, acting either directly or through his authorized assistants or representatives, who is responsible for engineering supervision of construction activities.

Equipment. All machinery and equipment, together with the necessary supplies for operation and upkeep, maintenance, and protection, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

Existing. The physical status as of the date of the invitation for bids of any structure, base, surface, subgrade, road, bridge, detour, or other unit affected by a particular project or designated highway.

Expansion Joint. A joint located to provide for expansion of a rigid slab, without damage to itself, adjacent slabs, or structures.

Extra Work. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

Extra Work Order. A change order concerning the performance of work or furnishing of materials involving extra work. Such extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

Faulting. Differential vertical displacement of rigid slabs at a joint or crack.

Flagman. An individual with a flag, stop/slow paddle, or other approved signaling device, whose duty is to signal vehicular traffic to: (1) come to a stop, (2) alter its speed and/or course, or (3) receive other instructions with reference to highway routes and their condition.

Flexible Pavement. A pavement structure which maintains intimate contact with and distributes loads to the subgrade and depends upon aggregate interlock, particle friction, and cohesion for stability.

Force Account Work. Work paid for by reimbursing for the actual costs for labor, materials, and equipment usage incurred in the performance of the work, as directed, including a percentage for overhead and profit, where appropriate.

Frontage Road. A local street or road auxiliary to and located generally on the side of an arterial highway, for service to abutting property and adjacent areas and for control of access to the highway.

Front Slope. The sloping surface of an embankment or roadway side ditch of which the downward inclination is away from the roadbed.

General Application Special Provisions. See “Special Provisions”.

Grade Separation. A structure, with its approaches, which provides for highway traffic to pass without interruption over or under a railway, street, or another highway.

Highway, Street or Road. A general term denoting a public way for purpose of vehicular travel, including the entire area within the right of way.

Holiday. See "Legal Holiday".

In Place. A term to denote that the unit price covers compensation for the item complete in place including all costs incidental to procurement, handling, hauling, and processing the item (including water) as required. The item will be measured and paid for in the manner provided in applicable sections of these specifications.

Inspector. The Engineer's authorized representative assigned to make detailed inspection of contract performance.

Interchange. A system of interconnecting roadways, in conjunction with one or more grade separations, providing for the movement of traffic between two or more roadways on different levels.

Intersection. The general area where two or more highways join or cross, within which are included the roadway and roadside facilities for traffic movements in that area.

Joint. A designed vertical plane of separation or weakness.

Laboratory. The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

Legal Holiday. Holidays which will be allowed in computing Contractor's time charges on a working day basis will be limited to the following days: Sundays, New Year's Day, Robert E. Lee's/ Martin Luther King's Birthday (the third Monday in January), George Washington's/ Thomas Jefferson's Birthday (the third Monday in February), Mardi Gras Day (Mobile and Baldwin Counties only), Confederate Memorial Day, National Memorial Day, Jefferson Davis' Birthday, Independence Day, Labor Day, Columbus Day/ Fraternal Day (the second Monday in October), Veterans' Day, Thanksgiving Day, and Christmas Day. All dates for legal holidays will be as prescribed by Alabama Act 250 of 1991. Dates for combined holidays are shown herein.

Leveling Course. The layer of material placed on an existing surface to eliminate irregularities prior to placing an overlaying course.

Load Transfer Device. A mechanical means designed to carry loads across a joint.

Local Road or Street. A street or road primarily for access to residence, business, or other abutting property.

Longitudinal Joint. A joint normally placed between traffic lanes to control longitudinal cracking.

Lot. A uniquely defined quantity of material from a single source, or homogeneous segment of construction, on which decision is made for acceptance.

Major Highway. An arterial highway with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.

Major Item. Any item having an original contract value in excess of 10 percent of the total contract bid price.

Major Street. An arterial highway with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.

Materials. Any substances specified for use in the construction of the project and its appurtenances.

Materials and Tests Engineer. The representative of the Chief Engineer of the Department that is responsible for the selection and control of all materials used in the construction the Department's transportation structures.

Material Vendor. A corporation, firm or individual who sells or rents supplies, equipment, or materials to a Contractor or Subcontractor or whose materials are prepared away from the construction premises and are delivered in final form to the construction site; such delivery being merely incidental to the sale. Material vendor must be a separate legal entity with independent investment in facilities and equipment and an independent business organization and operation, exercising a prerequisite degree of independent initiative, judgment, and foresight. A corporation, firm or individual which establishes a temporary plant or facility of any kind on or near a project for the purpose of furnishing material for that project only will not be considered a "material vendor" but will be considered a "Subcontractor" as defined in these specifications.

Median. That portion of a divided highway separating the traveled ways for traffic in opposite directions.

Median Lane. A speed-change lane within the median to accommodate left-turning vehicles.

Navigable Stream. A stream classed by the U.S. Coast Guard and/or the U.S. Army Corps of Engineers as navigable.

Notice to Contractors. See "Advertisement for Bids."

Notice to Proceed (Work Order). Written notice to the Contractor informing him of approval of his contract and notifying him to proceed with the contract work, including, when applicable, the date of beginning of contract time.

Original Ground. The ground surface just prior to the initiation of the proposed work.

Parking Lane. An auxiliary lane primarily for the parking of vehicles.

Pavement Structure. The combination of subbase, base, and surface placed on a subgrade to support the traffic load and distribute it to the roadbed.

Pay Item. See "Contract Item".

Plans. The contract drawings, which show the location, character, dimensions, and details of the prescribed work, including layouts, profiles, cross sections, and other details or reproductions thereof.

Prime Coat. An application of a low viscosity liquid bituminous material to coat and bind mineral particles preparatory to placing a base or surface course.

Professional Service. An individual or firm who provides highly specialized technical or unique functions in areas such as engineering, surveying, testing, inspection, certification, and environmental remediation. These services may or may not require professional licensure.

Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the contract.

Project. The specified section of the highway together with all appurtenances and construction to be performed thereon under the contract.

Project Manager. The Department's on-site representative who is in responsible charge of monitoring the Contractor's daily activities including the inspection of the work and the estimation of payment quantities.

Project Number. A number assigned for convenience to identify the work covered in a project.

Project-Specific Special Provisions. See "Special Provisions".

Proposal. The offer of a bidder, on the prescribed form, to perform the stated construction work at the prices quoted.

Proposal Form. The prescribed form on which the offer of a bidder is to be submitted.

Proposal Guaranty. The cashier's check or bid bond furnished with a bid to assure that the bidder will enter into the contract if his offer is accepted.

Questionnaire. The specified forms on which the Contractor shall furnish required information as to his ability to perform and finance the work.

Ramp. A connecting roadway between two intersecting highways, generally at a highway separation, or a sloping driveway giving access to a highway.

Random Sample. A small part of a lot which is used to represent the whole, so chosen that each portion of the lot has an equal probability of being selected.

Record Plans. Reproductions of plans issued to bidders as noted in Article 105.02.

Recovery Time. Recovery time is defined as the time required, after the controlling item or items of work have been substantially damaged as a result of conditions and causes beyond the control of the Contractor and not due to his negligence or fault, to restore the work to the condition existing prior to such damage so that normal operations can be resumed on the contract pay items. Recovery time shall be the number of days required by the Contractor, working with normal forces, to restore the work as described above.

Region. A geographic subdivision of the State for the purpose of executing the Department's construction, maintenance, and administrative activities. There are five regions within the State. Each Region is further subdivided into two Areas.

Region Engineer. The engineer in charge of one of the five Regions of the State.

Reinforcement. Steel embedded in a rigid pavement slab and in concrete structures to resist tensile stresses and detrimental opening of cracks.

Repetition, Avoidance of. See Article 101.01(c).

Reprocessing. The renewal of an existing surface by scarifying, remixing with or without additional material, and relaying.

Resurfacing. The placing of one or more new courses on an existing surface.

Retainage. The Department will not withhold retainage. Retainage is the money belonging to the Contractor which was held by the Department conditioned on final completion and acceptance of all work in connection with a project or projects by the Contractor.

Right of Way. A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

Rigid Pavement. A pavement structure which distributes loads to the subgrade having as one course a Portland cement concrete slab of relatively high bending resistance.

Rigid Slab. A section of Portland cement concrete pavement bounded by joints and edges, designed for continuity of tensile stress.

Road. A general term denoting a public way for purposes of vehicular travel including the entire area within the right of way.

Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder. The top surface of the roadbed is the subgrade.

Roadbed Material. The material below the subgrade in cuts and embankments, and in embankment foundations extending to such depth as affects the support of the pavement structure.

Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

Roadside Improvement or Development. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

Roadway. The portion of the highway within the limits of construction. A highway may have more than one roadway.

Seal Coat. A thin treatment consisting of bituminous material, usually with cover aggregate, applied to a surface course. The term includes, but is not limited to, sand-seal, chip-seal, slurry seal, contrast seal and fog seal.

Shop Drawings. Fabrication plans for any part of the work including, but not limited to, precast concrete items, structural steel items, or other metal items, and connections thereof, which the Contractor is required to submit to the Engineer.

Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

Skew Angle - Skew. The complement of the acute angle between two centerlines which cross; for a structure centerline, skew right means the right side of the structure is ahead; skew left means the left side of the structure is ahead.

Soil Survey. The exploration of the site of the proposed improvements by borings and tests or other methods and the preparations of soil profiles showing the significant layers, bedrock, water table, and other features.

Special Provisions. Additions and revisions to the Standard Specifications applicable to an individual project. Special Provisions include General Application Special Provisions and Project-Specific Special Provisions.

General Application Special Provisions. Additions and revisions to the Standard Specifications applicable to multiple projects. General Application Special Provisions shall prevail over Standard Specifications and plans.

Project-Specific Special Provisions. Additions and revisions to the Standard Specifications applicable to an individual project. Project Specific Special Provisions shall prevail over General Application Special Provisions, Standard Specifications, and plans.

Specifications. The compilation of provisions and requirements of prescribed work.

Specified Completion Date. The date on which the contract work is specified to be completed.

Speed Change Lane. An auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving the through traffic lanes.

Stabilization. Modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness, and resistance to weathering or displacement.

Standard Drawings. Drawings approved for repetitive use, showing details to be used where appropriate.

Standard Specifications. A book of specifications approved for general application and repetitive use.

State. The State of Alabama, the party of the first part to the contract, acting by and through the Transportation Director.

Station. One hundred feet {one hundred meters} measured horizontally.

Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way applicable to travel ways in urban areas.

Structures. Bridges, culverts, basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

Subbase. A layer or layers of specified or selected material or designed thickness placed on a subgrade to support a base or rigid pavement.

Subcontractor. An individual, partnership, firm, corporation or any acceptable combination thereof who has or have, with the written approval of the Department, contracted with the Contractor to execute and perform in his stead any part of the contract, as permitted by Article 108.01 of these Specifications. Material vendors as defined herein are not Subcontractors.

Subgrade. The top surface of the roadbed, upon which the pavement structure and shoulders are constructed.

Subgrade Treatment. Modification of roadbed material by stabilization.

Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames; including backwalls, wingwalls, and wing protection railings.

Superintendent. The Contractor's authorized representative in responsible charge of the work.

Superstructure. All that part of a structure above, and including, the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames; excluding backwalls, wingwalls, and wing protection railings.

Supplemental Agreement. A written agreement with the Contractor covering changes in the plans, specifications, or quantities or any combination thereof, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes.

Surety. The corporation, partnership or individual other than the Contractor executing a bond furnished by the Contractor, licensed under the laws of Alabama.

Surface. One or more layers of a material designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion and the disintegrating effects of climate. The top layer is generally called the wearing layer and the lower layer the binder layer.

Surface Treatment. One or more applications of bituminous material and cover aggregate or thin plant mix on an old pavement or any element of a new pavement structure.

Tack Coat. An application of bituminous material to an existing surface to provide bond with a superimposed course.

Temporary Structure. Any structure required to maintain traffic during construction of the work, which will be dismantled if required when the work is completed.

Through Highway. Every highway or portion thereof on which vehicular traffic is given preferential right of way, and at the entrances to which vehicular traffic from intersecting highways is required by law to yield right of way to vehicles on such through highway in obedience to either a stop sign or a yield sign, when such signs are erected.

Through Street. Every street or portion thereof on which vehicular traffic is given preferential right of way, and at the entrances to which vehicular traffic from intersecting streets is required by law to yield right of way to vehicles on such through highway in obedience to either a stop sign or a yield sign, when such signs are erected.

Tie Bar. A deformed steel bar or connector imbedded in the concrete across a joint to prevent separation of abutting slabs.

Traffic Lane. The portion of a traveled way for movement of a single line of vehicles.

Transportation Director. See "Director".

Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Typical Section. That cross section established by the plans which represents in general the lines to which the Contractor shall work in the execution of his contract.

Work (The Work). Work shall mean the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all duties and obligations imposed by the contract.

Working Day (Daytime Work). Any Calendar Day from midnight to midnight, exclusive of Saturdays and Legal Holidays (as defined herein), on which the Contractor could proceed with construction operations for a period of six hours or more with the normal working forces engaged in performing work on the controlling item or items of work, which normally would be in progress at that time, will be classified as a working day. Saturdays and Legal Holidays on which the Contractor elects to work for a period of four hours or more will be classified as a working day.

Working Day (Nighttime Work). (Where nighttime work is required, or allowed by the Engineer.) Any 24 hour period from noon to noon, on which the Contractor could proceed with nighttime construction operations for a period of six hours or more with the normal working forces engaged in performing work on the controlling item or items of work, which normally would be in progress at that time, will be classified as a working day. Saturdays and Legal Holidays on which the Contractor elects to work for a period of four hours or more will be classified as a working day.

Working Drawings. Erection plans, falsework plans, framework plans, cofferdam plans, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer.

(c) General Terms.

1. "NO DIRECT PAYMENT", "WITHOUT EXTRA COMPENSATION" AND "SUBSIDIARY OBLIGATION".

   Compensation shall be included in other items of work (other pay items) for work where it is shown that "no direct payment" will be made for the work, or that the work shall be done "without extra compensation", or the work shall be a "subsidiary obligation" of other items of work.

2. AVOIDANCE OF REPETITION.

   Wherever the terms "contemplated", or "required", "directed", "authorized", "considered necessary", "permitted", "approved". "suitable", "unacceptable", "designated", or terms of like import are used in these Specifications, they shall be construed to mean "to" or "by the Engineer" or "Director", unless the contract or context clearly indicates otherwise.

SECTION 102
PROPOSAL REQUIREMENTS AND CONDITIONS

102.01 Notice to Contractors (Advertisement).

(a) General.

Bids will be invited in a "Notice to Contractors" advertisement. The advertisement will contain the date, time, and place of opening bids; a description of the work; contract time; a stipulation as to the character and the amount of the proposal guaranty; and instructions to the bidders for obtaining access to plans and specifications.

(b) Adjustment of Bid Quantities.

The quantities shown in the "Notice to Contractors" are to be considered as approximate only and may be amended in the proposal to include additional quantities or additional items, or to decrease quantities or to exclude items of work before bids are to be received. This listing of quantities and pay items is to advise prospective bidders informally as to the type of work and approximate quantities involved.

102.02 Qualification of Bidders.

(a) Prequalification.

Proposal forms will be issued only to prospective bidders who have qualified with the Department and have a valid certification of qualification as required by State law. All applicants for qualification shall submit, under Oath, a complete confidential statement, equipment questionnaire, and experience questionnaire on forms that will be furnished by the Department upon request. To insure sufficient time for consideration, the applicant shall properly complete and submit the forms at least 14 calendar days prior to the date of opening bids on which the applicant desires to submit proposals. Forms received at a later date will be considered whenever practicable.

If the applicant is a corporation organized in a State other than Alabama, it shall furnish a certificate from the Secretary of State showing that it is qualified to transact business in Alabama. A bid for a 100 % State funded project will not be accepted from a corporation organized in another State if the bidder does not submit a valid Certificate of Existence issued by the Alabama Secretary of State. A bid will be accepted from a corporation organized in another State for a federally funded project but award of the contract is contingent upon receipt of the Certificate of Existence from the Alabama Secretary of State.

A prospective bidder will not be prequalified who has a corporate officer, director, or principal owner who is a corporate officer, director, or owner of another person which is presently disqualified by the Department. A prospective bidder will also not be prequalified who is an affiliate of a person that is presently disqualified by the Department.

For the purposes of this Section, the following definitions shall apply:

An **Affiliate** shall be defined as any person that controls, is controlled by, or is under common control with another person.

A **Person** shall be defined as an individual, a corporation, a partnership, an association, a joint stock company, a trust, or any unincorporated organization.

Control shall be defined as the ownership, directly or indirectly, of 10 % or more of the voting securities of a person or if the person is not a corporation, an ownership interest, directly or indirectly of 10 % or more of the person.

(b) Disqualification.

The Department reserves the right to disqualify or refuse to issue a proposal to a prospective bidder for the following reasons:

1. Lack of competency or adequate machinery, plant or other equipment as revealed by the required financial statement and experience questionnaires.
2. Uncompleted work which, in the judgment of the Department, could hinder or prevent the prompt completion of additional work if awarded.
3. Failure to pay or satisfactorily settle all bills due for labor and material on contracts in force at the time of issuance of proposals.
4. Failure to comply with any pre-qualification requirements of the Department.
5. Default, as defined in Article 108.12, under a previous contract.
6. Actions in bidding or subcontracting which have the effect of limiting competition and violating the competitive bid process, or if any partner, association member, corporate official or individual owner, respectively, of any bidder submitting a bid has been convicted or entered a guilty plea in any legal jurisdiction of the United States or any of the various States, of Federal or State crimes that involve the restraint of trade or limiting competition in any manner.
7. Suspension or debarment by the Federal Highway Administration of the prospective bidder or any partner, association member, corporate official or individual owner of the bidder.
8. Upon issuance to the contractor of two warning letters for DBE violations during any successive 24 month period. DBE violations apply on a company-wide basis and not for a particular project.
9. When the prospective bidder was the prime contractor and did not use his company's forces to perform at least 30 % of the work.
10. Disqualification for unsatisfactory progress as defined in Subarticle 108.04(e).
11. Being an affiliate of a person who is disqualified.
12. Becomes insolvent or commits any act of insolvency.
13. Failure to reimburse the Department in accordance with the requirements for payment given in these specifications, notwithstanding acceptance of the project or maintenance thereof.

Disqualification for reasons 1 through 6, 8 and 9 will be for an indefinite period of time. The status of disqualification will be reviewed if requested in writing by the disqualified firm. Any subsequent review of the status of disqualification will not be done until six months after the preceding review.

Disqualification for reason 7 will be for an indefinite period of time, with a minimum time of disqualification equal to the period of time of suspension or debarment by the Federal Highway Administration. After the minimum time of disqualification has passed, the status of disqualification will be reviewed if requested in writing by the disqualified firm. Any subsequent review of the status of disqualification will not be done until six months after the preceding review.

Disqualification for reason 10 will be removed immediately upon receipt of proof that the progress of the work is acceptable or that the project has been completed.

Disqualification for reason 11 will remain in effect until the prospective bidder causing the disqualification of the affiliate has been requalified.

Disqualification for reason 12 will remain in effect until the Contractor and Surety provide documentation to the satisfaction of the ALDOT that the Contractor's solvency has been restored.

Disqualification for reason 13 will be removed immediately upon receipt of satisfactory payment from the Contractor.

Disqualification applies to bidding as a prime contractor or performing work in any role or capacity on an ALDOT project.

(c) Requalification.

If a prospective bidder is disqualified from bidding for reasons 1 through 7, 9 and 12 given in Subarticle 102.02(b), it will be required to again prequalify under the provisions of Subarticle 102.02(a) above.

When requalified, the qualification will be issued subject to continued examination and evaluation of the Contractor's performance. The Contractor will be in probationary status for a period of one year following the requalification. If, during the period of probation, the Contractor is disqualified under any of the provisions of these Specifications, the Department may suspend the Contractor's right to requalify for a minimum period of one year.

102.03 Contents of Proposal Form.

(a) General.

The Department will furnish bidders a blank proposal form showing the location and description of the work contemplated, the approximate estimate of the various quantities of the pay items of the work to be performed and materials to be furnished, and the amount of the proposal guaranty. The proposal form may also contain "Special Provisions" and requirements that vary from, or are not included in, the Alabama Department of Transportation Standard Specifications. All papers bound with or attached to the proposal form are a necessary part thereof and must not be detached or altered.

The plans, specifications, and other documents designated in the proposal form shall be a part of the proposal whether attached or not. The prospective bidder shall pay the Department the fee set for each copy of the proposal form and each set of plans.

(b) Corrections.

Corrections and minor changes in the proposal form or plans may be put into effect by telegram, certified letter, express type mail, or other computer media from the Office Engineer Bureau, notifying all prospective bidders to whom proposal forms have been previously issued.

102.04 Interpretation of Quantities in Bid Schedule.

The quantities appearing in the bid schedule are approximate only and are prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted, or materials furnished, in accordance with the contract. The scheduled quantities or work to be done and materials to be furnished may each be increased, decreased, or omitted as provided herein.

102.05 Examination of Plans, Specifications, Special Provisions, and Site of Work.

The bidder is expected to carefully examine the site of the proposed work, the general and local conditions, and the requirements of the contract documents before submitting a proposal.

If boring logs, foundation reports, and other records of subsurface investigations were obtained by the State, this information is intended for State design and estimating purposes only. However, it is made available to bidders upon request so that they may have access to the identical subsurface information available to the State. The bidder shall examine this information and make their own interpretation as

to the nature and extent of material to be excavated, graded, bored, or driven through. The Department does not guarantee the amount or nature of the material which may be encountered. This information shall not be a substitute for personal investigation, interpretations and judgment of the bidders.

The submittal of a proposal shall be an acknowledgment that the bidder has made these examinations as required by this Article. Adjustments or compensation will not be allowed for losses caused by failure to comply with this requirement.

The State disclaims responsibility and liability for any opinions, conclusions, interpretations, or deductions that may be expressed or implied in any of the information presented or made available to bidders. The bidder shall be fully responsible for interpretations and conclusions made from all available information.

102.06 Preparation of Proposal.

(a) Proposal Form.

The bidder's proposal must be submitted by either one of the following procedures:

1. The submittal of the complete original proposal form, the bid item sheets generated by the computer file furnished by the Department, and a bidder furnished digital storage media containing the computer file downloaded from the Department's website with the bidder's prices or;
2. The submittal of the complete original proposal form directly to the Department and the submittal of the bid through the Department's approved Internet Bidding Service Provider.

Proposal forms are numbered serially and are not transferable.

Unless otherwise provided in the proposal, joint venturers may submit a proposal for a joint venture of qualified bidders on a proposal form issued to one of them, provided each venturer has taken out a proposal and provided the proposal is signed by each co-venturer. If the joint venturer chooses to submit a bid utilizing the Department's approved Internet Bidding Service Provider the joint venturer must request and receive approval for the joint venture. The joint venturer will be assigned a contractor identification number prior to the submittal of a bid.

(b) Details.

All bids shall be submitted using a computer bid system prescribed by the Department, via either bidder furnished digital storage media (CD-ROM, DVD-ROM, or USB flash drive), or the Department's approved Internet Bidding Service Provider. Bids submitted using any other form, format, or means will be rejected. The digital storage media used to submit the bid shall become the property of the State of Alabama.

Where alternate designs are provided by the plans and proposal, the bidder shall enter prices only on the items for the design alternate that will be most economical for the bidder to construct, and other bid items that will be common for all alternates.

If any item on the proposal form permits a choice between alternate specified types of materials, the bidder shall indicate by a check mark the type of material the bidder proposes to use. If more than one type or none is checked, the Department will make the selection.

Any interlineation, erasure, or other alteration of a figure shall be initialed by the signer of the proposal. The Department will check the extension of each item given in the proposal and correct all errors and discrepancies. In case of a discrepancy between a unit bid price and the extension amount, the unit price shall govern. The sum of the extension amounts will be the contract bid price.

A pay item may be shown with a maximum allowable amount for the bid. The bidder shall enter an amount for the bid that is equal to or less than the maximum allowable amount. If the bid entered is greater than the maximum allowable amount the Department will adjust the bid price to the maximum allowable amount for that item and recalculate the total bid amount.

A pay item may be shown with a minimum required amount for the bid. The bidder shall enter an amount for the bid that is equal to or greater than the minimum required amount. If the bid entered is less than the minimum required amount the Department will adjust the bid price to the minimum required amount for that item and recalculate the total bid amount.

(c) Signing.

The bidder's proposal must be signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the Contractor legally qualified and acceptable to the State. If the proposal is made by an individual, the individual's name must be shown; by a partnership, the name of each partnership member must be shown; as a joint venture, the name of

each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and of its corporate officials must be shown. Each bidder submitting a bid utilizing the Department's approved Internet Bidding Service Provider agrees that its digital signature constitutes an original signature.

The proposal bid bond, if bid bond is tendered, shall be properly signed by the bidder and the surety.

(d) Collusion.

Bidders will be required to execute a collusion affidavit conforming to the requirements of the laws and regulations cited in Article 107.05. If prior to the award the low bidder fails to execute the collusion affidavit the bid will be rejected and the bid bond will be forfeited. If there is any reason for believing that collusion exists among the bidders, any or all proposals may be rejected, and those participating in such collusion may be barred from submitting bids on the same or other work with the Department until they have been reinstated as a qualified bidder.

Only the affidavit form provided in the proposal will be acceptable.

(e) Computer Bidding.

The bidder shall use a bidding software program prescribed by the Department. It is the bidder's responsibility to gain access to computer equipment that will run the prescribed software program.

The bidder may choose to download the computer file and any addenda from the Department's website or the bidder may choose to utilize the Department's approved Internet Bidding Service Provider to access the computer file and addenda. If the bidder chooses to download the computer file from the Department's website and submit the bid using a digital storage medium, then the software program prescribed by the Department shall be used to prepare the bid and to print the official bid item sheets for submittal with the proposal form.

If the bidder chooses to utilize internet bidding, the computer file is available at the Department's approved Internet Bidding Service Provider's website.

The only entries permitted into the computer program when preparing the bid will be the unit or lump sum prices for items bid. The program will perform all extensions of the unit or lump sum prices, calculate the total bid, and print a complete set of bid item sheets including the total bid price and bid item signature sheet. Each bid item sheet will contain a check identification "ID" located in the bottom right corner of each bid item sheet corresponding to the check ID in the computer bid file.

Bid item sheets generated from the computer program shall be printed on 8.5 X 11 inch {216 mm x 279 mm} paper.

This set of bid item sheets, generated from the software program prescribed by the Department, along with a complete proposal package, will constitute the official bid. The computer generated bid item signature sheet and proposal shall be properly signed and delivered to the Department in accordance with Article 102.06(c), Signing, and Article 102.10, Delivery of Proposals.

Only bid item sheets printed from a software program prescribed by the Department will be accepted for the official bid. Failure to use and submit these bid item sheets will result in the bid being rejected. Bidders who choose to utilize internet bidding shall submit the bid as a computer file, including a digital signature, through the Department's approved Internet Bidding Service Provider.

All provisions of Subarticles (a) through (d) of this Article will apply to the preparation of bids that are submitted on computer program generated bid item sheets. Any necessary changes to entries on the computer program generated bid item sheets shall be made in accordance with Subarticle (b) of this Article.

A digital storage medium containing the computer file downloaded from the Department's website with the bidder's prices shall be submitted with the proposal unless the bidder chooses to use the Department's approved Internet Bidding Service Provider in which case the submittal of a digital storage medium is not required.

In case of a discrepancy between the unit or lump sum prices submitted on the program printed bid item sheets and those contained in the computer file returned to the Department, the unit or lump sum prices submitted on the program printed bid item sheets shall prevail in all cases.

Failure to submit a properly signed bid item signature sheet shall result in the bid being rejected.

Failure to submit a bid item sheet(s), other than the bid item signature sheet, will result in the bid being considered irregular in accordance with Article 102.07(a). In the event a bid item sheet is missing from the proposal, the Department may replace this sheet with a copy produced from the computer file submitted with the proposal.

The Department is not responsible for delay in completion of, or failure to timely submit, a bid due to an alleged website failure or failure of any service associated with the Department's approved Internet Bidding Service Provider.

102.07 Irregular Proposals.

(a) General.

Proposals will be considered irregular and may be rejected if they contain any omissions, alteration of form, additions not called for, incomplete bids (includes failure to enter a unit bid price on a bid item or, in the case of an alternate, the alternate being bid by the Contractor), interlineations, erasures or alterations not initialed by the person signing the proposal, inconsistent proposal control numbers on each computer bid item sheet and signature sheet, or other irregularities of any kind. Proposals may be rejected at any time prior to the execution of the contract by the Director.

Any bidder using the same or different names for submitting more than one proposal upon any project will be disqualified from further consideration on that project. Evidence that any bidder is interested, as a principal, in more than one proposal for work contemplated (for example bidding in a partnership, as a joint partnership or association, and as a partnership, association, or individuals) will cause the rejection of any such proposal. A bidder, however, may submit a proposal as principal and as a Subcontractor to some other principal, or may submit a proposal as a Subcontractor to as many other principals as he desires, and by so doing will not be liable to disqualification in the intent of these Specifications.

(b) Unbalanced Bidding.

In order that no party of the contract will be financially hurt over changes in the estimated quantities, a proposal may be rejected if any of the unit prices are obviously unbalanced. The Department will decide whether any unit prices are unbalanced either excessively above or below a reasonable cost analysis value determined by the Engineer, particularly if these unbalanced amounts are substantial and contrary to the interest of the Department.

102.08 Combination Bids.

(a) Combination Bidding

1. Bidder's Statement of Intent to Submit a Combination Bid.

A bid will be considered as a "combination bid" for two or more projects if the bidder notifies the Department in writing of the intent to submit a combination bid. The bidder shall submit a written statement that the bid will be either an "All or None" Combination Bid, a "Reduction in Unit Price" Combination Bid, a "Total Dollar Amount" Combination Bid or a "Total Number of Contracts" Combination Bid.

2. "All or None" Combination Bid.

The bidder shall clearly designate the proposals that are being combined in a bid that is being submitted as an "All or None" combination bid. The Department will evaluate all bids on these proposals and make awards based on the bids that are most advantageous to the State.

3. "Reduction In Unit Price" Combination Bid.

The bidder shall clearly designate the proposals that are being combined in a bid that is being submitted as a "Reduction in Unit Price" combination bid. The bidder shall clearly stipulate the reduction that will be made in the unit price of one or more of the items in any or all of the proposals if awarded the combination. The bidder will not be permitted to make a reduction in any unit price that is fixed by the Department. The Department will select the individual or combination bids that are most advantageous to the State.

4. "Total Dollar Amount" Combination Bid.

The bidder shall clearly designate the proposals that are being combined in a bid that is being submitted as a "Total Dollar Amount" combination bid. A bidder shall clearly stipulate that the bid is for designated projects but requests to be awarded work that will not exceed a designated total dollar amount. The Department will select the proposals that are most advantageous to the Department within the designated total dollar amount.

5. "Total Number of Contracts" Combination Bid.

The bidder shall clearly designate the proposals that are being combined in a bid that is being submitted as a "Total Number of Contracts" combination bid. A bidder shall clearly stipulate that the bid is for designated projects but requests to be awarded work that will not exceed a designated

number of contracts. The Department will select the proposals that are most advantageous to the Department within the designated total number of contracts.

6. Submittal of Written Statement of Notification of Combination Bid.

Regardless of the form of the submittal of the bid (paper, computer printout, Internet, etc.) the bidder shall notify the Department in writing of a bid that is being submitted as a combination bid. The written notification must be received in the office of the Department's Office Engineer Assistant Bureau Chief for Plans and Proposals prior to the opening of bids for a bid to be evaluated as a combination bid. The written notification shall be enclosed in the sealed bid package envelope or transmitted by facsimile to the number shown on the proposal cover sheet. The Contractor shall be responsible for verifying that the facsimile has been received by the Department prior to the opening of bids. The letter of notification of a combination bid shall:

1. Be addressed to the Transportation Director;
2. Describe the type of combination bid ("All or None", "Reduction in Unit Price", etc.);
3. Be dated no later than the date set for bid opening;
4. Be written on the bidder's letterhead;
5. Be signed by a person authorized to sign contracts for the bidder;
6. Contain a list of the project numbers included in the proposed combination bid.

7. Unacceptable Combination Bids.

A combination bid in which the bidder proposes that a lump sum be deducted from the final estimate is unacceptable. A combination bid in which the bidder proposes that a reduction in prices be made on a percentage basis is unacceptable. Unacceptable proposals for combination bids will be considered irregular by the Department and will be rejected.

(b) City and County Financed Projects.

Combination bids will not be accepted on any project or projects wholly or partially financed by a city unless all of the projects in the combination bid are city financed projects located in the same city.

Combination bids will not be accepted on any project or projects wholly or partially financed by a county unless all of the projects in the combination bid are county financed projects located in the same county.

102.09 Proposal Guaranty.

No proposal will be considered unless accompanied by a cashier's check drawn on an Alabama bank or a bid bond of the prescribed form made payable to the Alabama Department of Transportation in the amount indicated in the Notice to Contractors. The cashier's check shall have the name of the company submitting the bid and the project number on the check.

102.10 Delivery of Proposals.

Each proposal for each contract shall be placed, together with the proposal guaranty, in a sealed envelope on the outside of which is written in large letters "Proposals for Highway Work" and so marked as to indicate the project number, the county or counties in which the work is located and the name of the bidder. Proposals will be received in the office of the Department's Office Engineer Assistant Bureau Chief for Plans and Proposals at the Alabama Department of Transportation Building in Montgomery, Alabama, unless otherwise provided, until the hour and date set in the notice to Contractors for the opening thereof. No proposal will be considered which has not been received prior to the hour and date set for the opening of bids. Proposals received after that time will be returned. For bidders who choose to use the Department's approved Internet Bidding Service Provider the preceding is applicable with the exception that the bid sheet component of the proposal will be held at the Department approved Internet Bidding Service Provider's secure location. This bid sheet will be transmitted to the Department at the hour and date specified in the Notice to Contractors.

102.11 Withdrawal or Revision of Proposals.

A bidder may withdraw or revise a proposal after it has been deposited with the Department provided the request for such is received by the Department in writing or by telegram before the time set for opening proposals. Prior to the time set for opening proposals, a bidder who chooses to use the Department's approved Internet Bidding Service Provider may withdraw and revise a bid an unlimited number of times without notification or approval by the Department. No proposal can be withdrawn, modified, or corrected after the hour set for opening such proposals.

102.12 Public Opening of Proposals.

Proposals will be publicly opened and bid totals read aloud at the place, time, and date indicated on the "Notice to Contractors" advertisement. Bidders or their authorized agents are invited to be present.

102.13 Multiple Bids.

In the event that a bidder submits a bid utilizing a digital storage medium and paper submittal, and also submits a bid for that proposal utilizing the Department's approved Internet Bidding Service Provider, the internet bid will be accepted as the sole and exclusive bid.

102.14 Familiarity with Laws and Ordinances.

(a) General.

Bidders shall familiarize themselves with and shall comply with all Federal and State laws and local laws, ordinances, and regulations which may directly or indirectly affect the work or its prosecution, persons engaged in or employed on the work, and the equipment and tools used in the work. No adjustments or compensation will be allowed for losses caused by failure to comply with this requirement.

1. Contractor's Licensing for 100% State Funded Projects.

   Each bidder shall enter the General Contractors license number issued by the State Licensing Board on each submitted bid. Space is provided on the cover sheet of the proposal for the license number. Failure to enter the bidder's license number on the bid submittal will result in the rejection of the bid.

2. Contractor's Licensing for Projects Funded with Federal Monies.

   Prior to being awarded a contract, bidders on projects that are partially or wholly funded with federal monies shall submit a copy of their license issued by the State Licensing Board for General Contractors. Bidders may satisfy this requirement by placing a copy of the license into the proposal of each submitted bid.

3. Bidder's Responsibility.

   It is the bidder's responsibility to provide proof of being licensed by the State Licensing Board for General Contractors. Failure to do so may result in the rejection of a bid.

4. Codes.

   Attention is directed to Titles 23 and 39, Code of Alabama, 1975, also Title 23, U.S. Code, and amendments thereto to the date of the contract.

(b) Labor Rates.

Attention is called to the fact that the wage rates listed in the proposal are minimum required rates. Bidders therefore should investigate and determine the prevailing local wage rates which for certain classes may be higher than the listed minimum rates. Under no condition shall the Contractor pay less than the listed minimum rate but it may be necessary in some cases to pay more in order to secure the labor.

The bidders should investigate and the Contractor shall abide by any orders issued by the Wage Adjustment Board or any other Federal agency having jurisdiction over wage rates.

102.15 Material Guarantee.

The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

SECTION 103
AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals.

After the proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule multiplied by the unit bid prices.

The results of such comparisons will be available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals, if, in the judgment of the awarding authority, the best interest of the Department will be promoted thereby.

A proposal will not be considered unless signed by the bidder or his authorized agent and accompanied by cashier's check or properly signed bid bond as required by law.

For the purposes of Section 103, if the final calendar day specified falls on a weekend or holiday, the next business day will be the final calendar day.

103.02 Award of Contract.

(a) General.

The award of the contracts, if to be awarded, will be made within 30 calendar days after opening of proposals to the lowest responsible and responsive bidder whose proposals comply with the requirements of Section 102 and the invitation to bid (Notice to Contractors). Should no award be made within the 30 days, all proposals will be rejected unless the successful bidder agrees in writing to a stipulated extension in the time limit for award. The successful bidder will be notified by confirmed facsimile or letter mailed to the address shown on his proposal that his bid has been accepted and that he has been awarded the contract.

After the opening of bids on work involving Federal funds, the award of the contract to the low bidder will be contingent upon said low bidder obtaining a license from the State Licensing Board for General Contractors in accordance with the existing State laws.

(b) Bidder Low on More Than One Contract.

Should any responsible bidder be low on more contracts or work than he is qualified to handle under his certificate of qualification issued by the Department, the State reserves the right to select from his submitted proposals those for award to him which are most advantageous to the State. His other submitted proposals will not be considered in making the awards.

(c) Award Based on Bidder's Net Worth and Contracting Capacity.

The award of the contract will be made in consideration of the bidder's net worth and the dollar value of the bidder's contracting capacity in accordance with the legal requirements for public work. The bidder's contracting capacity is indicated on the face of the bidder's Prequalification Certificate.

The dollar value of the contracting capacity of a joint venture is the combined dollar value of the contracting capacity of each co-venturer.

Prior to the award of a contract to a joint venture a letter shall be submitted to the Department by the joint venture in which is given an approximate percentage of the work that is assigned to each co-venturer. This letter shall be signed by the same individuals that signed the joint venture's bid proposal and shall be notarized. The approximate percentages of participation shall be rounded to the nearest 5 % with no co-venturer being assigned less than 20 % of the work.

After the award of a contract to a joint venture, the dollar value of outstanding work in that contract will be assigned at the designated percentages to each co-venturer in determining the remaining contracting capacity of each co-venturer.

(d) Alabama Immigration Law

By signing this contract, the contracting parties affirm, for the duration of the agreement, that they will not violate federal immigration law or knowingly employ an unauthorized alien within the State of Alabama. Furthermore, a contracting party found to be in violation of this provision shall be deemed in breach of the agreement and shall be responsible for all damages resulting therefrom.

The Contractor shall submit a certificate of compliance form to the Department for each contract prior to award. This form must have an original signature, and the project will not be awarded without the form. The certificate of compliance form is available on ALDOT's website (http://www.alletting.dot.state.al.us) and shall be furnished to the Alabama Department of Transportation by the apparent low bidder within ten (10) days of the letting at the following address:

Alabama Department of Transportation
Bureau of Office Engineer, Contracts/Administrative Section
1409 Coliseum Boulevard, Room E-101
Montgomery, Alabama 36110

103.03 Cancellation of Award.

The Director reserves the right to cancel the award of any contract at any time before the execution of the said contract by all parties, without any liability against the State. The Director may also reject the bid of the lowest bidder if any of the conditions for disqualification noted in Article 102.02 are found to exist at any time prior to the execution of the contract by all parties. The Director may award the contract to the next lowest responsible bidder when it is determined to be in the best interest of the State.

103.04 Return of Proposal Guaranties.

All proposal guaranties, except those of the 3 lowest bona fide bidders, will be returned without undue delay after proposals have been checked, tabulated, and the relation to the proposals established. The proposal guaranty of the 3 lowest bona fide bidders will be returned as soon as the contract bonds and the contract of the successful bidder have been properly executed and approved. When the award is deferred for a period of time longer than 15 calendar days after the opening of the proposals, all proposal guaranties except those of the potentially successful bidders will be returned. Should no award be made, all guaranties will be returned. Should the successful bidder agree in writing to a stipulated extension in the time limit for award, the Director may, at his discretion, permit the successful bidder to substitute a satisfactory bidder's bond if a cashier’s check was submitted with his proposal as a proposal guarantee. The Director reserves the right to return all proposal guaranties by registered mail and his responsibility shall end upon the mailing thereof.

103.05 Requirements of Contract Bonds.

(a) Performance Bond.

The bidder to whom the award is made shall, within 15 calendar days after the prescribed forms have been presented to him for signature (i.e. after date of award), furnish and file with the Transportation Director an acceptable surety bond on the form included in the proposal in an amount equal to 100 percent of the contract bid price of the contract as awarded. Said bond shall be furnished by a surety company qualified and authorized to make such bonds in the State of Alabama, and countersigned by an authorized agent resident in the State who is qualified to execute such instruments. The bond shall have attached thereto power of attorney of the signing official unless such power of attorney is already on file in the office of the Department. In case of default on the part of the Contractor, all expense incident to ascertaining and collecting losses suffered by the State under the bond, including engineering, direct administration, and legal services, shall be charged against the contract bond for performance of the work.

(b) Labor, Materials, Services, Insurance, Feed Stuffs, or Supplies Bond.

In addition thereto, the bidder to whom the award is made shall, within the same 15 calendar days, execute and file with the Director an acceptable surety bond payable to the State in an amount not less than 100 percent of the contract bid price, with the obligation that the Contractor shall promptly make payment to all persons furnishing him or them with labor, materials, feed stuffs, services, insurance, bond, or supplies for or in the prosecution of the work, and for the payment of reasonable attorneys fees, incurred by successful claimants or plaintiffs in suits on said bond.

(c) Continuous Bond Coverage.

Surety bonds shall continue to be acceptable to the Director throughout the life of the contract. In event the surety executing the bonds, although acceptable to the Director at the time of execution of the contract, subsequently becomes insolvent, bankrupt, unreliable, or otherwise unsatisfactory due to any cause which becomes apparent after the Director's initial acceptance of the bonds, then the Director will require that the Contractor replace the bonds with like bonds drawn on a surety company which is acceptable to the Director. In such event, all costs of the premium for the new bonds will be borne by the Contractor.

(d) Performance of Surety.

The Department will not accept bonds from a surety that has failed to perform in accordance with the terms of any bond that the surety has submitted to the Department. Prospective bidders will be informed in the "Notice to Contractors" that a surety's bonds are unacceptable.

103.06 Execution of Contract.

The contract shall be executed by the bidder to whom award is made, on the form included in the proposal, and returned to the Director with satisfactory contract bonds within 15 calendar days after the

prescribed forms have been presented to him for signature (i.e. after date of award). Should extenuating circumstances prevail, the Director may grant an extension in time not exceeding five calendar days for the return of the contract and bonds as provided herein and in Article 103.05.

103.07 Approval of Contract.

A period of 20 calendar days will be allowed for execution of the contract by the Director and approval of same by the Governor, after its presentation by the successful bidder, unless the successful bidder agrees in writing to a longer period. No contract is binding upon the State until it has been executed by the Director and approved by the Governor of the State. The date of the final execution of the contract shall be the date on which it is signed by the Governor.

103.08 Failure to Execute Contract.

If the successful bidder is awarded the contract and fails to execute the contract (including furnishing acceptable contract security) the bidder will be subjected to the following actions.

The Director will obtain liquidated damages for the bidder's default. The amount of the damages will be the smaller of two possible amounts. The first possible amount is the total amount of the proposal guaranty. The second possible amount is the difference between the amount of the contract as awarded and the amount of the total bid of the next lowest responsible bidder. The damages will be recovered from the bidder's cashier's check guaranty or from the principal or the sureties if the guaranty is a bid bond.

The Director will return the proposal guaranty intact to the estate of the deceased successful bidder in the event of the death of the successful bidder on the date of the opening of the bids or the death of the successful bidder during the following number of days allowed for the execution of the contract.

The defaulted bidder will be prohibited from participating in any manner in the original contract, and will be prohibited from participating in any manner in any portion of that contract that may be removed and put into other contracts. These prohibitions shall apply to any other name under which the same person, affiliate, individual, partnership, company, firm, corporation, association, cooperative, or other legal entity may be operating in which the principal owners are involved. The prohibitions shall be:

- Work will not be allowed as a subcontractor or in any other capacity or role on the project.
- Bidding will not be allowed on the original contract if it is readvertised for letting.
- Bidding will not be allowed on any subsequent contract which contains any portion of the original contract.

SECTION 104
SCOPE OF WORK

104.01 Intent of Contract.

The intent of the contract is to provide for the construction and completion of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

When Item 680-A, Geometric Controls, is included on the plans and in the proposal, the Contractor shall also furnish all geometric controls (see Section 680).

Special provisions covering any special conditions, materials, or construction not covered on the plans or in these specifications will be included in the bidders' proposals or in supplemental agreements.

104.02 Alterations of Plans or Character of Work.

(a) General.

The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the contractor agrees to perform the work as altered.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the contract. If the cost of the work does not change, then the adjustment will be zero. The basis for the adjustment shall be agreed

upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the contractor in such amount as the Engineer may determine to be fair and equitable.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

The term "significant change" shall be construed to apply only to the following circumstances:

(1) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or

(2) When a major item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed. Changes in quantities for the items of Unclassified Excavation, Muck Excavation, Borrow Excavation, Pipe Underdrain, extra Concrete and Steel Reinforcement (for structure foundations), Piling, Bituminous Plant Mix leveling and widening material, and Bituminous Material used in plant mix bases and pavements, Disposal of Hydrocarbon Contaminated Soil, Underground Storage Tank (UST) Removal, and Removing and Disposing UST Contents shall be excluded in determining increases and decreases under the provisions of this paragraph, since it is understood that these items cannot be accurately determined before the work is done.

No claims shall be made by the Contractor for any anticipated profits because of any such alteration, or by reason of any variation between the approximate quantities and the quantities of work as done.

No allowance will be made on an item for which a fixed price is set in the proposal.

Payment for work occasioned by changes or alterations will be made in accordance with the provisions set forth under Article 109.05. If the altered or added work is of sufficient magnitude as to require additional time in which to complete the project, such time adjustment may be made in accordance with the provisions of Article 108.09.

Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

(b) Changed or Differing Site Conditions.

During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions, and if he determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the Contractor of his determination whether or not an adjustment of the contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

The Contractor shall carry on the work promptly and diligently pending a decision.

Any adjustment in compensation because of such change or changes will be made in accordance with the provisions of Article 109.05. Any adjustment in contract time because of such change or changes will be made in accordance with the provisions of Article 108.09.

(c) Claims.

If the Contractor does not agree with the Department’s decision concerning his request for extra compensation, he may file a claim following the procedures outlined in Section 110, Claims.

104.03 Extra Work.

(a) General.

The Contractor, when so directed in writing, shall perform extra work for which there is no quantity or unit price in the contract and is deemed necessary or desirable in order to complete fully

the work as contemplated. Such work shall be performed in accordance with the Specifications and as directed and will be paid for as provided under Subarticle 104.03(b).

(b) Supplemental Agreement or Force Account Order Required.

Before any such extra work is started, a supplemental agreement shall be executed, describing the kind, location, and estimated quantities of the extra work to be done and specifying the unit prices or lump sum agreed upon, or a written order shall be issued for the work, stating that compensation will be on a force account basis. However, in an emergency, the Engineer may direct the immediate start of the extra work by letter containing this information. Such letter shall be superseded later by a supplemental agreement or force account order. If satisfactory unit prices or lump sum cannot be agreed upon, the Director may require that the extra work be performed on a force account basis as outlined in Subarticle 109.04(b) or he may direct that one or more of the items of the proposed extra work be omitted from consideration and performed by other agents.

104.04 Maintenance of Traffic and Sequence of Construction.

(a) General.

1. Provision for Traffic.

No highway or section of highway or bridge shall be closed to traffic and no construction operations that will for any reason render the roadway generally unsuitable for use of the traveling public shall be started until adequate provisions have been made to detour or by-pass the traffic in safety and comfort. Special reference is made to Article 107.07, "Public Convenience and Safety" and such is approved in writing by the Engineer.

2. Pipelines and Public Utilities.

The Contractor's attention is directed to the possible existence of pipe lines or other public utilities which may be buried within the limits of the work or adjacent thereto and which may or may not be shown on the plans. He shall be responsible for and shall take all necessary precautions to protect and preserve any and all such existing drains, sewers, pipes, conduits, and other underground structures or parts thereof which may be affected by his operations on the work, and which, in the opinion of the Engineer, may be properly continued in use without any changes. He shall assume full responsibility for reimbursing the owners for any damage or injury to properties or interference with their service which may result from any of his operations or negligence during the period the contract is in force. Also, he shall be responsible for any damage to utilities above ground, regardless of their location, where such damage results from any of his operations or his negligence. Attention is directed to Subarticle 107.12(b).

The Contractor shall repair, replace, relocate, extend, reconstruct or make any other change in any subsurface sewer or drain encountered in the prosecution of the work and unless otherwise provided in the contract, the cost of replacing or restoring or connecting any such sewer or drain substantially to its original location, when incidental to the construction shall be included in the contract unit prices for various pay items.

3. Mail Delivery.

Where mail delivery service is to be maintained during construction, mailboxes within the limits of operations shall be removed by the Contractor before work is begun and set temporarily where they will be accessible both to the mail carrier and the patron. As soon as the state of the work permits and the Engineer directs, all mailboxes shall be reset by the Contractor in permanent locations in compliance with U.S. Postal Service Regulations. Mailboxes or supports that have been damaged by the Contractor shall be replaced at his expense. The cost of removing and/or temporarily resetting mailboxes shall be included in the prices bid for the various pay items of work and no direct payment will be made for this work. Unless Item 209-A, Mailbox Reset, is included on the plans or in the proposal, no direct payment will be made for permanently resetting mailboxes.

4. Lighting for Nightime Operations.

When the Contractor performs any operations after daylight hours, he shall provide and maintain, at his expense, sufficient artificial lighting to permit proper construction and inspection.

(b) Signs and Warning Lights.

All signs, barricades, etc. used along the project shall be in accordance with the provisions of Part 6 of the MUTCD, the plan details and the following: Posts shall be appropriately sized for the sign of either timber (treated or painted) of not less than 4 inch by 4 inch {100 mm x 100 mm} (Nom.) cross section or metal (min. 2 lbs. {1 kg} "U" channel or equivalent) so spaced to rigidly support the sign.

All signs, barricades, drums or other devices intended for use in controlling traffic shall be in accordance with the requirements of Part 6 of the MUTCD and the detailed plans, with reflectorization as noted therein. Reflectorization shall be accomplished using materials meeting the requirements of Article 880.02.

All barricades, drums, signs and other devices shall be kept clean, legible, and in their proper position at all times. Damaged, defaced or dirty barricades, drums, signs and other devices shall be repaired or replaced immediately. The Engineer will insure compliance by periodic inspections and require replacements or repair as deemed necessary.

In addition to the requirements of Article 107.10 where particular hazardous conditions exist or traffic volumes warrant, or where there is serious interference from extraneous light sources and a reflectorized sign is not likely to be effective, the Engineer may require any or all signs and barricades to be illuminated.

Illumination of signs, barricades, etc. shall be accomplished by the use of 100 watt or greater, incandescent or equivalent fluorescent electric light bulbs, shielded to protect the driver from glare and so located that the sign shape and message is clearly visible to the driver. Street or highway lighting by itself is not regarded as meeting illumination requirements.

(c) Sequence of Construction.

Unless otherwise provided by plan details or special provisions included in the contract, the sequence of construction for the project shall be the Contractor's provided the following requirements are met to the satisfaction of the Engineer.

1. Provides for the orderly construction of the project within the time limit provided by the Contract.
2. Provides for the preparation of any bridge sites as a first order of work.
3. Provides for handling of traffic through the work in accordance with the details noted in Subarticle (d) of this Article.
4. Provides for the working out of minor drainage problems and details of temporary or permanent access as they are encountered.
5. Provides for the continuous prosecution of all paving work through the final wearing layer once planing (milling) operations, surface treatment operations, or paving operations have begun.

(d) Handling of Traffic.

Unless otherwise provided, the Contractor shall keep the road open to all traffic while performing the required improvements. The Contractor shall keep the portion of the project being used by public traffic, whether it be through or local traffic, in such condition that traffic will be adequately accommodated. He shall provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. Where so provided on the plans or approved by the Engineer, the Contractor may bypass traffic over an approved detour route.

The Traffic Control Plan (TCP) has been developed by the Engineer in accordance with Part VI of the "Manual on Uniform Traffic Control Devices" (MUTCD). The Contractor shall furnish, erect, and maintain barricades, warning signs, delineators, flagmen, and pilot cars in accordance with the TCP. The TCP will be revised as directed by the Engineer if there is a need for traffic control that is not shown on the TCP.

The need for maintaining the flow of traffic may cause the restriction of the movement and operation of the Contractor's construction equipment. Flagmen shall be furnished without additional compensation to direct traffic and protect the work as noted in Section 740.

Construction adjacent to existing pavement will require the use of portable barricades, drums, signs, vertical sign panels, delineators, or other approved traffic control devices. Posts used for traffic control device supports shall be appropriately sized for the intended purpose and uniform in shape and color throughout the project.

The above traffic control devices shall be supplemented as necessary with warning lights of the kind and type indicated by plan details, the proposal, or as directed by the Engineer. In addition, when deemed necessary by the Engineer, special warning lights shall be used on equipment working adjacent to traffic lanes to warn traffic. These special warning lights shall be either all purpose, 360°-2 sealed beams, revolving types of at least 8 inches {200 mm} in height, or electronic strobe beacons. These lights shall be amber or orange colored and mounted so as to be readily seen by traffic at a safe distance.

104.05 Blank.

104.06 Final Cleaning Up.

Upon completion and before work will be finally accepted and final payment made, the Contractor shall perform the following work: (1) He shall clear and remove from the right of way and adjacent areas not owned by him, all falsework, equipment, surplus and discarded materials, temporary structures, rubbish, debris, and all other objectionable litter, and dispose of them in a satisfactory manner. (2) He shall not remove barricades, warning and direction signs, until directed by the Engineer. (3) He shall remove from the site of other operations such as pits, quarries, stream channels, structures sites, and storage yards, all weeds, portions of trees, discarded materials, machinery, temporary structures, and equipment and dispose of them in a satisfactory manner. Depositing such material on abutting property or adjacent to the right of way with or without the consent of the property owner, will not be accepted as satisfactory disposal. However, he may be allowed temporarily to store equipment, surplus material, usable forms, etc., in a neat manner on a well-kept site near the right of way. (4) He shall restore in an acceptable manner all property, public and private, damaged incident to the prosecution of the work, and shall leave the right of way and sites of structures in a neat and presentable condition satisfactory to the Engineer.

104.07 Maintenance of Roads and Detours.

(a) General.

The Contractor shall maintain at his expense, except as explicitly outlined in this Article, all detours and haul roads, and all roads, streets, bridges, and intersections within the project limits. This includes, but is not limited to, haul roads and detours constructed by the Contractor for his convenience. It also includes damage to the road, street, or structure caused by the Contractor's equipment.

The Contractor shall regulate his loads as required by Article 105.12 and he and his surety shall be responsible for any specific damage that may result to the road, street, or structures from failure to observe regulations governing traffic thereon, or for negligence on his part.

The Contractor shall perform required repairs without delay; otherwise, the State or County will perform the repairs and the cost thereof will be deducted from amounts due on the contract. The Contractor and his surety shall indemnify and hold harmless the State, the Director, and the Engineer for damages arising from the use of roads and streets in the performance of the contract.

(b) Detours.

Detours designed by the Engineer and constructed in an acceptable manner shall be maintained by the Contractor with payment made under the appropriate Pay Items or as Extra Work unless the State elects to perform the maintenance instead. Roads designated as detours by the plans or the Engineer shall be maintained as outlined in this paragraph.

(c) Haul Roads.

Unless the plans designate otherwise, the Contractor may use any State road as a haul road with the maintenance performed as specified in Subarticle 104.07(b) above as long as his loads are regulated as specified in Subarticle 104.07(a) above.

Should the Contractor wish to use a county road or city street as a haul road, he shall meet with the local governing body, review the condition of the facility, and reach an agreement as to the maintenance thereof. No payment will be made for such maintenance or restoration thereof.

(d) Roads and Bridges.

Existing roads and bridges which have not been constructed or overlaid by the Contractor shall be maintained by the State unless the Contractor is directed to make repairs with payment to be made as specified in Subarticle 104.07(b).

104.08 Value Engineering.

(a) Purpose and Scope.

Value Engineering (VE) applies to cost reduction proposals that are initiated, developed, and submitted in writing by the Contractor to the Department for modifying the plans, the specifications, or other contract requirements. This applies only to a proposed change which is identified as a Value Engineering proposal at the time it is submitted to the Department.

VE proposals are those which would require a change in the contract and would result in a net savings over the contract cost without impairing essential functions and characteristics of the project,

including but not limited to, service life, reliability, economy of operation, ease of maintenance, desired aesthetics, and safety.

The intent of this provision is for the Department to share with the Contractor any cost savings generated on a project as a result of a proposal or proposals offered by the Contractor and approved by the Department. The purpose is to encourage the use of the Contractor's ingenuity and experience in arriving at alternate, lower cost construction methods than those reflected in the contract documents by the sharing of savings resulting therefrom. VE proposals based solely on deleted pay items will not be considered.

Nothing herein shall be construed as requiring the Department to consider or approve a VE proposal submitted hereunder; however, if a VE proposal is approved by the Department, the net savings resulting from the proposal will be shared by the Department and Contractor on a 50-50 basis.

(b) Submittal of Proposal.

As a minimum, the following materials and information shall be submitted with each VE proposal, plus any additional information requested by the Department:

1. A Statement that the proposal is being submitted as a Value Engineering proposal.
2. A description of the difference between the existing contract requirements and the proposed change, and the comparative advantages and disadvantages of each, including considerations such as service life, economy of operations, ease of maintenance, desired appearance, and safety.
3. A complete detailed cost analysis indicating the final estimate costs and quantities to be replaced by the proposal, the new costs and quantities generated by the proposal, and the cost effects of the proposed changes on operational, maintenance, and other considerations.
4. Plans, specifications, and recommendations as to how the VE proposed changes are to be accomplished.
5. A statement of the deadline for issuing a change order adopting the proposed change to obtain the maximum cost reduction during the remainder of the contract, noting any effect on the contract completion time or delivery schedule.
6. A description of any previous use or testing of the proposal on another Department project, or elsewhere, and the conditions and results therewith. If the proposal was previously submitted on another Department project, indicate the date, project number, and the action taken by the Department.
7. VE proposals may be submitted only by the prime Contractor. Subcontractors may not submit a proposal except through the prime Contractor.
8. Six complete copies of all submittal data included in a VE proposal shall be submitted to the Department's Project Manager. All copies of the proposal will be forwarded through the Area Office to the Construction Engineer for further handling.

(c) Conditions for Consideration of Proposal.

1. The Contractor is cautioned not to base any bid prices on the anticipated approval of a VE proposal and to recognize that a proposal may be considered but not approved. In the event of rejection of the proposal, the Contractor shall complete the contract in accordance with the plans and specifications at the contract prices bid.
2. The Department will not be liable to the Contractor for failure to accept or act upon any VE proposal submitted nor for any delays to the work attributable to any such proposal.
3. The Contractor shall absorb all costs incurred in preparing a VE proposal for submission to the Department including the cost of final plan revisions. The Department will bear the cost of reviewing and administering the VE proposal.
4. Until a proposal is approved by supplemental agreement, the Contractor shall remain obligated to the terms and conditions of the existing contract.
5. All VE proposals, whether approved or not approved by the Department for use on a referenced project, become the property of the Department, and shall contain no restrictions imposed by the Contractor on their use or disclosure. The Department shall have the right to use, duplicate, and disclose in whole or in part any data necessary for the utilization of the proposal. The Department retains the right to utilize any accepted proposal or part thereof on any other or subsequent projects without any obligation to the Contractor. This provision is not intended to deny rights provided by law with respect to patented materials or processes.
6. The proposal shall not be experimental in nature but shall have been proven to the Department's satisfaction under similar or acceptable conditions on another project or location.

7. Proposed changes in the basic design of a bridge or pavement type, or which require different right-of-way limits, will not normally be considered as an acceptable VE proposal. Items of work which are specifically excluded from Value Engineering by the plans will not be considered as a VE proposal.
8. If a supplemental agreement has not been executed by the date upon which the Contractor's proposal specifies that a decision should be made, or such other date as the Contractor may subsequently have specified in writing, such proposal shall be deemed rejected.
9. If additional information is needed to evaluate proposals, such information shall be provided in a timely manner. Failure to do so will result in rejection of the proposal.
10. If a VE proposal is accepted in whole or in part, such acceptance will be by a contract supplemental agreement. The supplemental agreement will incorporate the necessary changes in the plans and specifications to permit the proposal, or any part of it accepted, to be put into effect. If there is to be an extension or reduction in contract time, the supplemental agreement will so note. If the approval of the Department is conditional, the supplemental agreement will specify the conditions.
11. The Department will be the sole judge as to whether a proposal qualifies for consideration and evaluation. It may reject any proposal that requires excessive time or costs for review, evaluation, and/or investigations, or which is not consistent with the Department's design policies and basic design criteria for the project.

(d) Value Engineering Payment.

If a VE proposal is approved by the Department, the changes and payment therefore will be authorized by a supplemental agreement. Reimbursement to the Contractor will be made as follows:

1. The changes shown on the VE proposal will be incorporated into the contract through plan revisions, changes in the quantities of unit bid items, newly agreed price items or by force account, as appropriate, in accordance with the specifications.
2. The cost of the revised work will be paid for directly as determined from the above mentioned changes. In addition to such payment, the Department will pay to the Contractor, by a separate Lump Sum Item, an amount equal to one-half of the savings as reflected by the difference between the cost of the original contract work and the cost of the work performed under the approved VE proposal. Payments will be made on monthly estimates based on the estimated savings generated by the approved VE proposal. The amount to be paid on these estimates will be a percentage of the total estimated savings in proportion to the amount of the VE proposal work performed during that month. Upon completion of all work included in the VE proposal, the final total savings will be determined by comparing the cost of the work based on the original contract quantities and the cost of the actual VE work performed. The final payment for work performed under the VE proposal will make any necessary corrections in previous payments to reflect a total payment of 50% of the generated savings to the Contractor.
3. The Contractor's costs for development, design, and implementation of the VE proposal are not eligible for reimbursement.
4. The Contractor may submit VE proposals for an approved subcontractor but, if the proposal is approved, the reimbursement will be made by the Department to the Contractor.
5. Payment will be made under item number:

104-A Value Engineering Proposal No. _____ - per lump sum

SECTION 105
CONTROL OF WORK

105.01 Authority of the Engineer.

The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

The Engineer shall have the authority to withhold further payment or to suspend the work wholly or in part due to failure of the Contractor to correct conditions unsafe for the workmen or the general public; failure to carry out provisions of the contract; failure to carry out orders; for such periods as he

may deem necessary due to unsuitable weather; for conditions unsuitable for prosecution of the work; or for any other condition or reason deemed to be in the public interest.

105.02 Plans and Drawings.

(a) Plans.

Each sheet of the record set of plans, except cross section sheets, will be stamped "Record Plans", and will be signed and dated by a representative of the Department. The Contractor will be furnished a copy of the record set of plans. The Contractor shall have at least one set of construction plans available on the construction site whenever work in being performed.

The general details of construction, and the location where the work is required, will be shown on the plans. The basis of payment for construction will also be shown on the plans.

Roadway plans will have a title sheet, alignment, profile, typical cross section, and other information applicable to the work. Details will also be given for highway lighting, signals, utility relocation, and other work associated with roadway construction. Structural plans (bridges, culverts, pipes, retaining walls, etc.) may be included in the roadway plans.

The Contractor shall supplement the construction plans with drawings for fabrication (Shop Drawings) and construction methods (Working Drawings). Shop drawings and working drawings shall be submitted as a part of the verification that the materials and methods selected by the Contractor for fabrication and construction will be in accordance with the requirements given in the contract and will not be detrimental to the quality of completed roadway facility.

(b) Shop Drawings.

1. Preparation of Drawings.

When shown as a contract requirement, the Contractor shall prepare and submit shop drawings for approval. Shop drawings shall be the proposed fabrication details for structural members and components.

Shop drawings for structural steel members and components shall be prepared on 22 inch {559 mm} x 36 inch {915 mm} size plan sheets.

Shop drawings for structural members other than structural steel shall be prepared on 22 inch {559 mm} x 36 inch {915 mm} size plan sheets or, with prior approval of the Bridge Engineer, on 11 inch {280 mm} by 17 inch {430 mm} sheets.

The Contractor shall carefully verify and shall become fully responsible for the correctness of all dimensions other than the principal controlling dimensions shown on the plans. The Contractor shall immediately advise the Engineer of any errors or discrepancies that are found during the preparation of the drawings.

All drawings shall be clear and complete. The signature of the preparer shall be shown on all drawings.

Any details not sufficiently shown on the plans will be furnished by the Engineer upon request by the Contractor.

2. Submittal.

Shop drawings shall be submitted by the Contractor to the Bridge Engineer for review and approval. Two copies shall be submitted for an initial review. At the completion of the initial review, one copy will be returned to the Contractor that will be marked "No Exceptions Taken" or marked with corrections to be made. Resubmittals of two copies will be required until the drawings are marked "No Exceptions Taken".

3. Distribution of Drawings For Structural Steel.

After the Contractor receives the "No Exceptions Taken" copy of the drawings, the original drawings shall be submitted to the Bridge Engineer with one copy. The original drawings will be stamped approved and returned to the Contractor for the production of sets of copies for distribution.

The Contractor shall submit four copies of the approved and stamped drawings for distribution. Additional copies may be submitted for distribution if requested by the Contractor.

Revisions of the shop drawings after approval shall be made on the original drawings. All revisions shall be clearly noted and dated on the drawings. The revise original and one copy shall be submitted to the Bridge Engineer for approval. The approved revised originals will be returned to the Contractor. The Contractor shall submit four copies of the revised original for distribution.

The Contractor shall submit one set of satisfactory reproducibles (Mylar or equal) of the final approved shop drawings. The reproducibles shall be delivered to the Bridge Engineer at the completion of the fabrication work.

4. Distribution of Drawings for Members other than Structural Steel.

After receiving the approved copy of the drawings, the Contractor shall submit ten copies of the approved drawings for distribution by the Department. Additional copies may be submitted for distribution if requested by the Contractor.

5. Time Allowed for Review.

Ten calendar days shall be allowed for each review of each set of drawings containing five sheets or less and two days shall be allowed for each sheet of each set of drawings containing more than five sheets.

If the review is not completed within the number of days allowed, and the delay is not the fault of the Contractor, the delay will be considered for an extension of contract time.

6. Approval.

The approval of drawings will not release the Contractor from being solely and fully responsible for the accuracy of the drawings. Extra work that may result from errors in the shop drawings shall be done without additional compensation.

7. Beginning Fabrication upon Approval.

Fabrication shall not begin until the drawings have been approved. There will be no compensation for, or acceptance of structural members and components that are fabricated prior to approval of the drawings.

(c) Working Drawings.

1. Preparation of Drawings.

The Contractor shall prepare and submit working drawings to supplement the plans. Working drawings shall be prepared to provide a complete illustration of the construction methods and materials proposed for use by the Contractor. Design calculations shall be submitted with the drawings. The signature, seal, and date of signature shall be placed on all details and design calculations by a Professional Engineer that is licensed in the State of Alabama and not employed by the ALDOT.

Working drawings and design calculations shall be submitted for:

1. Cofferdams, sheeting and shoring near a railroad track;
2. Cofferdams where "cofferdam and pumping" is required;
3. Structural steel girder erection plans for continuous span bridges;
4. Temporary bracing to provide stability for bridge girders;
5. Stay-in-place bridge deck forms;
6. Falsework for bridge deck overhangs (portion of deck outside of exterior girders);
7. Falsework for bridge bent caps;
8. Proposed temporary bridges;
9. Temporary steel sheet pile walls;
10. Falsework for the support of the top slab of cast in place concrete culverts;
11. Proposed placement of cranes on bridges;
12. Construction loads on bridges.

Working drawings and design calculations shall be submitted for any other construction process where noted on the plans or shown to be required in these specifications.

The Contractor shall be fully responsible for all of the costs of unacceptable construction work whether or not working drawings are submitted for the construction procedures and temporary materials that affect the quality of construction.

2. Submittal.

Six copies of working drawings and design calculations shall be submitted by the Contractor to the Construction Engineer. The drawings and calculations shall be submitted well in advance of the point in time when the work will be performed.

Working drawings for work on or over the railroad right-of-way must have the approval of the railroad company before the work will be allowed to begin. The Contractor shall submit four extra sets of drawings and design calculations for use by the Construction Engineer in obtaining a review by the railroad company. The Contractor shall make the submittal far enough in advance of the need for the work to begin so that the railroad company will have ample time to review the drawings and design calculations.

Working drawings and design calculations that have been submitted and distributed to ALDOT construction personnel by the Construction Engineer may be resubmitted for another project provided

all requirements are identical in nature to the previous project. The resubmittal of working drawings and calculations shall be signed, sealed and dated again by the Professional Engineer that originally sealed the drawings. The Professional Engineer shall clearly indicate on the drawings and calculations that the resubmittal is applicable to the new work.

3. Distribution.

The drawings and design calculations will be checked for completeness. The drawings will be distributed to ALDOT construction personnel for inspection of the work. The distribution of the drawings will not release the Contractor and the Professional Engineer from being solely and fully responsible for the accuracy and adequacy of the drawings. Extra work that may result from errors in the working drawings and design calculations shall be done without additional compensation.

4. Beginning Work shown on Working Drawings.

Construction shall not be performed on any item of work for which Working Drawings are required until the Engineer receives the drawings for inspection of the work. There will be no compensation for work that is performed prior to the point in time that ALDOT personnel have the drawings for use in inspecting the construction work.

(d) Compensation for Drawings.

There will be no direct payment for the preparation and submittal of shop drawings, working drawings and design calculations. The cost of the drawings and calculations shall be included in the contract unit prices for the items of work.

105.03 Conformity with Plans and Specifications.

All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements, including tolerances shown on the plans or indicated in the Specifications.

In the event the Engineer finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and Specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgement.

Where definite tolerances are specified in the contract, such tolerances shall fix the limits of reasonably close conformity. Where tolerances are not specified in the contract, the Engineer will determine the limits of reasonably close conformity in each individual case and his decision shall be final and conclusive and mutually accepted by all parties.

In the event the Engineer finds the materials furnished, work performed, or the finished product are not within reasonably close conformity with the plans and Specifications, the work shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, and Special Provisions.

(a) General.

These specifications, the plans, special provisions and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complimentary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions, unless obviously incorrect, shall govern over scaled dimensions. Plans shall govern over Standard Specifications. General Application Special Provisions shall govern over Plans and Standard Specifications. Project Specific Special Provisions shall govern over General Application Special Provisions, Standard Specifications, and Plans.

(b) Errors.

The Contractor shall not take advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 Cooperation with Utilities and Non-Highway Public Facilities.

It will be the State's duty to notify in writing all utility owners or other parties affected, of the date they may begin adjustments of their facilities. The State will endeavor to have all necessary adjustments of public or private utilities, or other appurtenances within or adjacent to construction limits, made as

soon as practicable. The owners or operators of private or public utilities shall have access to the work for the installation, adjustment, or repair of main line and service facilities. All frames of openings for valves, manholes, catch basins, or other fixtures encountered in areas to be covered by a pavement, shall be adjusted to the proper elevation before the pavement is placed. The Contractor shall coordinate his activities with those of utility owners while utility adjustments are being made. Copies of utility agreements will be made available for the Contractor's inspection at the Alabama Department of Transportation Area offices. The Contractor shall investigate conditions of existing utilities prior to submitting his bid for the purpose of coordinating the work to the greatest extent possible.

The Contractor's attention is directed to any utilities that may be involved on this project and are designated in the Plan Assembly. In any event, it shall be the Contractor's responsibility to determine the exact location of all existing utilities, whether shown on the Plans or not. The relocation and/or adjustments of said utilities have been authorized and utility facilities have been cleared or adjusted; however, should additional points of conflict occur, they will, of necessity, be performed during the construction operation. Cooperation between the Contractor and the Utility Companies shall be expected in accordance with this Article.

Any existing underground utilities, whether indicated on the plans or not, that have been abandoned by the Utility Companies within the limits of construction that require removing shall be removed by the Contractor. Any material removed in this manner shall become the property of the Contractor. Disposal of said material shall be at his discretion outside of the right-of-way limits. Cost of such work shall be paid for under applicable contract items of work or as Extra Work as outlined in Article 104.03.

105.06 Cooperation by the Contractor.

(a) General.

The Contractor will be supplied with a minimum of two sets of approved plans and contract assemblies (except Standard Specifications) including Special Provisions. The Contractor shall purchase any required Standard Specifications from the Department.

One set of approved plans and one copy of the contract assembly, including the Standard Specifications shall be kept available on the work at all times.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other Contractors in every way possible.

(b) Contractor's Superintendence and Supervision.

The Contractor shall have on the work at all times, as his agent, a competent superintendent capable of reading and speaking English and capable of thoroughly understanding the plans and specifications. The superintendent shall be thoroughly experienced in the type of work being performed and will receive instructions from the Engineer or his authorized representatives. The Superintendent shall have full authority to execute orders or directions of the Engineer without delay and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Joint venture Contractors shall have one such superintendent for all ventures. Such superintendents shall be furnished irrespective of the amount of work sublet and shall have full authority over all subcontract work.

105.07 Cooperation Between Contractors.

(a) General.

The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of the other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

The Engineer is empowered to regulate and coordinate the stages or progress of construction, or items of work of the respective Contractors to affect necessary cooperation and satisfactory performance and completion. The Engineer's decision shall be binding in any dispute involving the work arising between Contractors.

(b) Right of Way for Structure Contractor.

Except as provided in Subarticle (a) above, the structure Contractor shall have available for his operations and storage the right of way between abutments and for a distance of up to 150 feet {45 m} (unless otherwise shown on the plans) back of the face of each abutment of each proposed structure along the main road, depending upon site conditions.

In the case of an underpass structure, the structure Contractor will have the use of the right of way for a distance of up to 150 feet {45 m} (unless otherwise shown on the plans) on each side of the centerline of the structure, depending upon site conditions. He shall provide a minimum 12 foot {3.7 m} vertical and 14 foot {4.2 m} horizontal clearance through the falsework of such structure, for movement of construction equipment. He shall keep open and not interfere with roadways or detours for public travel. He shall have right of access to each structure along the roadbed location or other portion of the right of way and shall not be barred from such access by operations of other Contractors. He shall not by his operations bar passage of other Contractors between sections of their work beyond each end of a structure.

105.08 Construction Stakes, Lines, and Grades.

(a) For Projects Containing Item 680-A, Geometric Controls, the Following Shall Apply:

The furnishing of construction stakes, lines, and grades shall be as outlined in Section 680.

(b) For Projects Not Containing Item 680-A, Geometric Controls, the Following Shall Apply:

1. Determination of Lines and Grades.

The Engineer will set construction stakes for the Contractor establishing all the lines, grades, and measurements necessary for the proper prosecution of the work. The location, alignment. and elevation of all parts of the work will be established by the Engineer, but the Contractor shall assume full responsibility for construction to the alignment, elevations, and dimensions as indicated by the stakes and/or plans. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall govern and execute the work. For all work, the Engineer will furnish the Contractor all lines, elevations, and bench marks needed to lay out the work correctly. No work shall be done without lines and grades having been given by the Engineer.

For control of elevations of base and pavement layers, the Contractor will be furnished one set of control elevation stakes. These stakes will be set on grade at intervals of not more than 50 feet {20 meters} along and near each side of each roadbed, and at other points as needed for accurate grade control. It shall be the Contractor's responsibility to obtain from this one set of control stakes the proper elevations for each layer of subbase, base, and pavement.

2. Contractor's Responsibility for Stakes.

The Contractor shall be responsible for the preservation of all stakes and marks. If in the opinion of the Engineer, any of the construction survey stakes or marks have been carelessly destroyed or disturbed by the Contractor, the cost to the State of replacing them will be charged against him, and will be deducted from the payment for the work.

3. Furnishing Stakes, Templates, etc.

The Contractor shall furnish free of charge, all stakes, templates, and other materials necessary for marking and maintaining points and lines given, and shall furnish the Engineer such incidental labor as he may require in establishing points and lines necessary to the prosecution of the work to satisfactory completion.

105.09 Inspectors, Assistants, and Representatives.

(a) General.

The Engineer may appoint such inspectors, assistants, or representatives as he deems necessary, and they shall be granted full access to the work and to the mills and factories in which material is being prepared for use under the contract. In County Aid work, the Engineer may appoint the County Engineer as his representative on the work.

(b) Duties of the Inspector.

Inspectors will be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications, or to act as foreman for the Contractor; however, he shall have the authority to reject work or materials until any questions at issue can be referred to and decided by the Engineer.

105.10 Inspection of Work.

(a) Access to the Work for Inspection by the Engineer.

All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good the parts removed, will be at the Contractor's expense.

When any unit of government, political subdivision, utility company, or railroad corporation is to pay a portion of the cost of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government, political subdivision, utility company, or railroad corporation a party to this contract, and shall in no way interfere with the rights of all parties.

(b) Failure of the Engineer to Discover and Reject Defective Materials and Work.

The Contractor shall bear the costs of replacing defective materials and work including the occurrence of the Engineer failing to promptly discover and reject defective materials and work.

105.11 Removal of Unacceptable and Unauthorized Work.

All work which does not conform to the requirements of the contract will be considered as unacceptable work.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness or due to any other cause, shall be removed immediately and replaced in an acceptable manner.

Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, work performed without sublet approval by the Engineer if the work is performed by forces other than the Contractor's forces, or any extra work done without authority will be considered as unauthorized. If the quality of the unauthorized work is acceptable to the Engineer, the work may be left in place without payment. If the quality of the unauthorized work is unacceptable, the work shall be removed and replaced.

Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer made under the provisions of this Article, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to deduct the costs from any monies due or to become due the Contractor. Continued failure on the part of the Contractor to comply shall be considered sufficient cause for the Director to declare the contract in default and to proceed to have the work completed in accordance with Article 108.12.

105.12 Oversize/Overweight Vehicle Permit and Load Restrictions.

(a) Oversize/Overweight Vehicle Permit.

An Oversize/Overweight Vehicle Permit may be required for moving oversized and overweight loads. The Vehicle Permit Office of the ALDOT should be contacted to obtain information concerning the special requirements (such as police escorts) for moving these loads.

(b) Load Restrictions.

The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. In the hauling of materials on city streets or county roads, it shall be the responsibility of the Contractor to regulate his loads so that damage does not occur,

regardless of the legal or posted load limit. Maintenance of public roads shall be as outlined in Article 104.07. A special permit will not relieve the Contractor of liability for damage which may result from the moving of material or equipment.

Within the project limits, loads shall be so regulated that damage will not occur to base or pavement layers and structures, but in no case shall loads exceed the legal load limit unless permitted in writing by the Engineer under special conditions. No loads will be permitted on base, pavement or structures before the expiration of any required curing period. The Contractor shall be responsible for all damage by his hauling and other construction equipment within the project limits.

Gross weight {mass} tickets for loads delivered to the project will be verified by the Engineer that all loads incorporated in the project are within the legal load limit. Required information for verification will be secured at the time of delivery; however, verification of weights {masses} may be made at any time during the project.

On loads of materials not accompanied by a gross weight {mass} ticket, the Contractor shall furnish, upon request of the Engineer, the tare weight {mass} of any truck delivering such materials to the project. These truck tare weights {masses}, along with appropriate volumes and conversion factors, will be used by the Engineer in determining approximate quantities of materials which may be hauled to the project and remain within the legal load limit. If the Engineer feels that the legal load limit is being exceeded, he may order the Contractor to verify the weight {mass} of designated loads at an approved truck scale.

Payment will be made only for that portion of a load up to and including the legal load limit. No payment will be made for any portion of a load exceeding the legal load limit.

105.13 Maintenance of the Work.

(a) General.

The Contractor shall maintain the work during construction until the entire project is completed and accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway or structures are kept in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

The Contractor's attention is directed to Article 104.07 for maintenance of roads and detours, and compensation thereof.

(b) Compensation.

All cost of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.14 Failure to Maintain Work.

If the Contractor, at any time, fails to comply with the provisions of Article 105.13, the Engineer will immediately notify the Contractor of such non-compliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor on his contract.

105.15 Acceptance.

(a) Construction Acceptance Inspection.

Whenever the Engineer considers the work provided for and contemplated by the contract is nearing completion, or within two weeks of written notice of presumptive completion of the entire project by the Contractor, the Area Operations Engineer and all pertinent personnel (such as Area construction, project, county transportation, and maintenance personnel, FHWA, county, municipal or other owner representatives as applicable) will inspect all the work in the contract. The Contractor should not presume completion of the entire project until permanent vegetation is established. If the Area Operations Engineer finds that the work has not been satisfactorily completed at the time of such inspection, the Contractor will be advised in writing as to the work to be done or the particular defects to be remedied to place the work in condition for acceptance for maintenance purposes. The Contractor will have a maximum of four weeks to correct and complete the items listed. Time charges should resume if the work is not completed in the four weeks.

(b) Partial Acceptance for Maintenance.

When requested by the Contractor in writing, the Engineer may consider accepting a portion of the contract for maintenance prior to all items of work being completed. This will apply to specific items or operations of being restricted by seasonal limitations or check periods in accordance with 108.07c or 108.09 or work as directed by the Engineer. All other contract items of work shall be satisfactorily complete.

The Engineer will notify the contractor that they will assume maintenance of specific items or operations of work and will also indicate which items are not accepted. The partial acceptance letter to the contractor should also detail the disposition of time charges for the remaining work.

Additional costs for completing the remaining items of work as a consequence of a partial acceptance such as traffic control and remobilization shall be borne by the Contractor. Partial acceptance shall in no way void or alter any terms of the contract.

Once the remaining items of work have been satisfactorily completed, the Engineer will accept the portion of work and assume maintenance of the project henceforth.

(c) Final Acceptance.

1. General.

Upon due notice from the Contractor of presumptive completion of the remaining items of work in Subarticles (a) and (b) above, the Area Operations Engineer and all pertinent personnel will make an inspection. If all construction provided for and contemplated by the contract is satisfactorily completed, that inspection shall constitute the final inspection.

2. Vegetation Bonds.

When directed by the Engineer, the Contractor shall provide a vegetation bond covering sustained growth of established or planted vegetation. The bond shall be of sufficient value to cover all costs associated with the replanting or reestablishment of the vegetation should it become necessary. The dollar amount of the bond shall be the costs for the labor, materials and equipment required for traffic control, temporary erosion and sediment control, and permanent vegetation establishment. The period of time covered by the bond will not be required to be greater than 12 months unless shown otherwise on the plans. Vegetation bonds should not be used as a substitute for established vegetation of a permanent species.

3. Acceptance for Maintenance.

Upon satisfactory completion of the work as noted in Item 105.15(c)1 above, the Area Operations Engineer will notify the Construction Engineer that the Contractor has completed all work required by the contract. After the Construction Engineer has concurred with the Area Operations Engineer’s recommendation, the Construction Engineer will advise the Contractor in writing that the work has been accepted and the Department will assume the maintenance thereof subject to the "record check" of materials and workmanship.

4. NPDES Termination

Within 10 days of Acceptance for Maintenance, the Engineer will request NPDES Permit Termination as outlined in Subarticle 107.21(e). The Contractor shall be responsible for stormwater runoff control on the project until the storm water permit is terminated or 30 calendar days after the Engineer’s request for termination has been processed, whichever is less. The Contractor is also responsible for correcting problems associated with onsite erosion and offsite sedimentation deposition during this time.

5. Contractor's Advertisement of Completion.

The Contractor, immediately after receiving Notice of Acceptance for Maintenance, shall give notice of said completion by an advertisement for a period of four successive weeks in some newspaper in general circulation published within the county in which the project is located. If the project is located in more than one county, an advertisement shall be given in a newspaper of general circulation published within each county in which the project is located. Proof of publication of said notice shall be made by the Contractor to the Director, by affidavit of the publisher. If a newspaper is not published in a county where work is done, the notice may be given by posting at the Court House for 30 days and proof of same shall be made by the Probate Judge or Sheriff and the Contractor.

6. Written Notice of Final Acceptance.

After completion of all requirements noted in this Article and Article 109.12, the Engineer will process the Final Estimate for payment. At this time, the Construction Engineer will give the

Contractor written notice that the project is completed, and will specify that date as Final Acceptance.

105.16 Claims for Adjustments and Disputes.

Claims shall be handled as provided in Section 110, Claims.

SECTION 106
CONTROL OF MATERIALS

106.01 Source of Supply and Quality Requirements.

(a) General.

Attention is directed to Section 800, Materials, which includes additional Specifications for materials.

The materials furnished for use in the work shall be new unused materials, unless otherwise specified, meeting all quality requirements of the contract. In order to expedite the inspection and testing of materials, the Contractor shall notify the Engineer of his proposed sources of materials prior to delivery. At the option of the Engineer, materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or, if the product from any source proves unacceptable at any time, the Contractor shall furnish acceptable materials from other approved sources. The Engineer shall have the right to reject the entire output of any source from which he finds it is impracticable to secure a continuous flow of uniformly satisfactory materials.

1. Federal Participating Projects.

a. Steel and Iron Products.

Steel/iron materials from the initial melting and mixing of these materials and all manufacturing processes including the stage of applying a coating to these materials (epoxy coating, galvanizing, painting, or any other coating that protects or enhances the value of the coated material) that are permanently incorporated into the completed project shall be produced domestically (in the United States, its territories, or possessions). If any part of the project (defined by and including the NEPA document) is funded by Federal-aid, then the entire project must meet the Buy America provisions, including utility relocation reimbursements for Federal-aid funds authorized after October 1, 2012.

If the dollar amount of the foreign source steel/iron is less than $2,500 or 0.1% of the contract amount, whichever is greater, the foreign source steel/iron can be used in the project.

The Contractor shall provide certification that the steel/iron is domestically produced.

b. Convict Produced Materials.

Materials produced after July 1, 1991, by convict labor are prohibited from being incorporated in the work unless such materials have been:

- Produced by convicts who are on parole, supervised release, or probation from a prison or
- Produced in a qualified prison facility and the cumulative annual production amount of such materials for use in Federal-aid highway construction does not exceed the amount of such materials produced in such facility for use in Federal-aid highway construction during the 12-month period ending July 1, 1987. "Qualified prison facility" means any prison facility in which convicts, during the 12-month period ending July 1, 1987, produced materials for use in Federal-aid highway construction projects.

c. Cargo Preference Act.

Materials or equipment that are acquired solely for a Federal-aid project must comply with the requirements of 46 CFR 381. Clauses 46 CFR 381.7(a)-(b) are hereby incorporated into these Specifications by reference.

2. Non-Federal Participating Projects.

On projects financed entirely by the State of Alabama or any political subdivision thereof, the Alabama Legislature has passed Acts that require the exclusive use of American materials, products, and supplies as follows:

a. Steel Products.

The content of Alabama Code Section 39-3-4 is as follows: "(a) Any contractor for a public works project, financed entirely by the State of Alabama or any political subdivision thereof, within this state shall use steel produced within the United States when specifications in the construction contract require the use of steel and do not limit its supply to a sole source under subsection (f) of Section 39-2-2. If the awarding authority decides that the procurement of the above mentioned domestic steel products becomes impractical as a result of a national emergency, national strike, or other cause, the awarding authority shall waive the above restriction. (b) In the event the contractor violates the domestic steel requirements of subsection (a), and domestic steel is not used, there shall be a downward adjustment in the contract price equal to any realized savings or benefits to the contractor."

b. Non-Steel Materials, Supplies and Products.

The content of Alabama Code Section 39-3-1 is as follows: "(a) The awarding authority contracting for a public works project to be financed entirely by the State of Alabama or any political subdivision of the state, shall stipulate or cause to be stipulated in the contract a provision whereby the person, firm, or corporation undertaking the project agrees to use in the execution of the contract materials, supplies, and products manufactured, mined, processed, or otherwise produced in the United States or its territories, if the same are available at reasonable and competitive prices and are not contrary to any sole source specification implemented under subsection (f) of Section 39-2-2. (b) In the event the contractor breaches the agreement to use domestic products, and domestic products are not used, there shall be a downward adjustment in the contract price equal to any realized savings or benefits to the contractor."

c. Sole Source Reference [Alabama Code Subsection 39-2-2(f)].

In the rare case that a sole source material is required from a non-domestic source the Department will make the determination of what the Contractor will be required to furnish.

(b) Clearances and Acknowledgments for the Use of Offsite Areas.

1. Types of Regulatory Clearances and Acknowledgments.

The regulatory clearances and acknowledgments shown in the following table are required for material pits, waste areas, haul roads, material stockpiles, long term equipment parking areas and other offsite areas selected by the Contractor to utilize in the construction of the project.

REGULATORY CLEARANCES AND ACKNOWLEDGMENTS FOR THE LONG TERM USE OF OFFSITE AREAS	
1.	Applicable Construction Stormwater Discharge Permitting from the Alabama Department of Environmental Management.
2.	Historical and Archeological clearance from the Alabama Historical Commission.
3.	Written acknowledgement from the U.S. Fish and Wildlife Service that there will be no adverse affect on endangered and threatened species protected under the Endangered Species Act.
4.	Written acknowledgement from a Professional Biologist that wetlands will not be adversely affected.

2. Submittal of Copies of Regulatory Clearances and Acknowledgments.

The Contractor shall submit copies of clearances and acknowledgments as verification that regulatory authorities are aware of the offsite activity and that the activity will not adversely impact natural resources.

Clearances and acknowledgements will not be required for offsite areas used for short term parking, staging or material stockpiling where the activity does not require clearing or grading. Only a copy of applicable ADEM permitting will be required for offsite areas commercially owned and operated by a third party that is not an ALDOT contractor or subcontractor.

(c) Operation of Offsite Pits and Waste Areas.

The operations of any material pit or waste area shall be so conducted that it will blend into the surrounding landscape. Pit sites and waste areas shall be dressed to obliterate any unsightly appearance and treated in such a manner that erosion will not occur and result in the pollution of the watershed area. In general, sources will not be permitted at locations where resulting scars are visible from any highway. However, when approved, adequate space for conservation of existing natural screenings or

to permit the installation of screen planting between the road surface and the disturbed area shall be provided.

The Contractor shall accept full responsibility for the quality of the materials used. The Contractor shall make all necessary arrangements with the owners of the materials; pay the purchase price or royalty directly to the owners and bear all the expense of procuring and delivering the materials complete in place, including cost of ingress and egress, and including the cost of opening, developing, and operating such sources.

If the Contractor submits a written request to the Department asking that the Department run samples or analyses on the materials, the Department may, at its option, run such samples or analyses, but a charge will be made for the tests and the cost deducted from the next monthly estimate due the Contractor.

Where access to a material source or waste area requires removal of fencing, the removal and replacement of fence, together with the protection of any livestock affected, shall be the responsibility of the Contractor without direct compensation.

Use of existing public roads for hauling materials to be used in the work shall be governed by Article 104.07.

(d) Blank.

(e) Blank.

(f) Use of Materials with Special Acceptance Requirements.

The Alabama Department of Transportation maintains several lists of materials, sources, and devices, which have undergone some form of preliminary evaluation. These lists are established both as reference for Contractors and as methods to eliminate some of the lengthy time delays required in evaluating certain products. Each list is unique in requirements and job control acceptance. Users of these lists should read all requirements carefully before using products on them. When materials or products shown on these lists are used, they shall be selected from the most current applicable list at the time of installation, regardless of the materials and products that may have been shown on the lists prior to the date of installation. These lists are published in the Department's manual "MATERIAL, SOURCES, AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS" (MSDSAR), which is available on the Department’s website.

The lists are not a blanket approval and do not relieve the Contractor of the responsibility of furnishing quality materials. The Project Manager will inspect the material, and if doubt exists, job control samples will be taken. If these job control samples indicate failing test results, one of the following actions will be taken depending on the detrimental effects to the project:

1. Previously installed materials may be ordered replaced with passing materials at no cost to the Department.
2. Previously installed materials, which are of a temporary nature, may be left in place with the Contractor maintaining the failing materials for the duration of their use at his expense.
3. Previously installed materials may remain in place with an agreed price reduction.

After failing job control results are received, no further installation of the failing material will be allowed and a determination will be made by the Department as to the removal of the product from the list.

The lists are established and maintained by the individual sections within the Department of Transportation who are primarily concerned with the products. Lists are divided into five general categories of similar requirements. They are:

1. Qualified Sources of Materials
2. Approved Materials
3. Qualified Materials
4. Approved Traffic Control Devices and Materials
5. Qualified Traffic Control Devices and Materials
6. Approved Intelligent Transportation System Devices and Materials

The Alabama Department of Transportation Product Evaluation Board has final authority for addition or removal of products from these lists. The Bureau of Materials and Tests duplicates and disseminates these lists.

General information concerning materials, sources, and devices with special acceptance requirements is contained in ALDOT-355. Information concerning items on these lists or how to get an item onto one of these lists may be obtained by contacting:

Alabama Department of Transportation
Bureau of Research and Development
1409 Coliseum Boulevard
Montgomery, AL 36110
(334) 206-2240

106.02 Samples, Tests, Cited Specifications.

(a) General.

All material used in the work shall be inspected, tested and approved by the Engineer, Inspection and testing shall be in accordance with the current Departmental Testing Manual. Any work in which untested materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the Engineer, shall be removed at the Contractor's expense. The Engineer may permit use prior to sampling and testing of certain materials accompanied by a signed materials guaranty on the form furnished by the Department guaranteeing the material conforms to Departmental Specifications. Such material may be tested at any time and, if found unsatisfactory, shall be removed and replaced with satisfactory material at no additional cost to the Department. The Engineer reserves the right to refuse permission for use of materials on the guaranty basis at any time.

The Contractor shall furnish the Department, free of charge, ample quantities of such samples as are necessary or required by the Engineer to test adequately any and all materials. Any damage caused by in-place testing when such is specified shall be repaired by the Contractor without additional compensation. Samples will be taken by or under the supervision of a representative of the Engineer. Required or designated tests will be made by and at the expense of the State unless otherwise noted on the plans or in the specifications, in accordance with the most recent standard, interim, or tentative standard methods of ALDOT, AASHTO, ASTM or F.S.S. in force and on file with the Department at the date of advertisement for bids, indicated date of adoption notwithstanding, except where standard or special drawings are included in the plans. Then the AASHTO, ASTM, or F.S.S. in effect on the date of the latest revision to the drawing shall govern.

(b) Plant Inspection.

The Engineer may undertake the inspection of materials at the source. Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods and material samples will be obtained for laboratory testing for compliance with materials quality requirements. This may be the basis for acceptance of manufactured lots as to quality.

In the event plant inspection is undertaken, the following conditions shall be met:

1. The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom he has contracted for materials.
2. The Engineer shall have full entry at all times to such parts of the plant as may concern the manufacture or production of materials being furnished.
3. If required by the Engineer, the Contractor shall arrange for an approved building for the use of the Inspector; such building to be located conveniently near the plant, independent of any building used by the material producer, and conforming to requirements of Article 106.03.
4. Adequate safety measures are to be provided and maintained. It is understood that the Department reserves the right to retest all materials prior to incorporation into the work which have been tested and accepted at the source of supply, after the same have been delivered, and to reject all materials which, when retested, do not meet the requirements of these specifications or those established for the specific project.

(c) Supply of Tested Materials.

The Contractor shall regulate his supply so that at all times there will be a sufficient quantity of tested and accepted materials on hand to prevent any delay to the work.

106.03 Field Laboratories.

(a) General.

The laboratories furnished for use shall be roofed, insulated and weather tight with suitable operational air-conditioning and heating facilities for year-round use. Each unit shall be wired for electrical service and in addition the following minimum requirements are applicable to the particular type of laboratory required.

Compensation for the field laboratories shall be in accordance with Section 601.

(b) Base, Soil and Structure Laboratories.

This type laboratory shall contain not less than 200 square feet {18.5 square meters} of floor space (minimum width 8 feet {2.4 m}) with a 7 foot {2.1 m} (minimum) ceiling height and shall contain suitable work benches and drawers. The laboratory shall be portable and shall be independent of other buildings or office space used by the Contractor. It shall have not less than two windows and one outside door, both of which shall be screened and of adequate size to facilitate ventilation of the unit. Location of the laboratory shall be as directed by the Engineer. In addition each unit shall be provided with the following equipment:

1. Double sink with running water (minimum 100 gallon {375 liter} supply).
2. Lights, when requested by the Engineer.
3. Three laboratory burners (one combined unit or separate) (gas type shall have minimum capacity to supply the burners five working days).
4. Laboratories for use at rock crushing operations shall also include an approved mechanical shaking machine for screening samples and shall have power for operating the machine.

Cabinets and shelving shall be provided as appropriate.

(c) Concrete Plant Laboratories.

Concrete plant laboratories shall contain not less than 200 square feet {18.5 square meters} of floor space. These laboratories shall have a minimum width of not less than 10 feet {3 m} with a 7 foot {2.1 m} (minimum) ceiling height and shall contain suitable work benches and drawers. A waiver of the 10 foot {3 m} width requirement may be granted for mobile, trailer type laboratories after an inspection of the lab's suitability has been made and approved. The laboratory may be a portable, a permanent, or a partitioned portion of a permanent structure provided it meets the requirements of these specifications. The unit shall be independent of plant storage, office space, etc., and shall have one private entrance door that can be secured. The laboratory shall be located as directed by the Engineer with window space suitable to the Engineer for periodic observation of plant operations. All outside windows and doors shall be screened. In addition each shall be provided with the following equipment:

1. Single sink with running water (minimum 100 gallon {375 liter} supply).
2. One laboratory burner or oven.
3. Lights.
4. Shelves and cabinets shall be provided as appropriate.

(d) Asphalt Plant Laboratories.

Asphalt plant laboratories shall contain not less than 450 square feet {41.8 square meters} of floor space and shall be of sufficient size to allow the required independent laboratory equipment to be used simultaneously by the contractor and the state. These laboratories shall have a minimum width of not less than 10 feet {3 m} with a 7 foot {2.1 m} (minimum) ceiling height and shall contain suitable work benches and drawers. A waiver of the 10 foot {3 m} width requirement may be granted for mobile, trailer type laboratories after an inspection of the lab's suitability has been made and approved. The laboratory may be a portable, a permanent, or a partitioned portion of a permanent structure provided it meets the requirements of these specifications. The unit shall be independent of plant storage, office space, etc., and shall have at least one private entrance door that can be secured. The laboratory shall be located as directed by the Engineer with window space suitable to the Engineer for periodic observation of plant operations. In addition each shall be provided with the following equipment:

1. Single sink with running water (minimum 100 gallon {375 liter} supply).
2. One laboratory burner or oven.
3. Lights.
4. Shelves and cabinets shall be provided as appropriate.
5. All asphalt plant laboratories shall be equipped with an exhaust fan, sufficiently sized and located to effectively clear the laboratory of smoke and fumes in a reasonable, in the judgment of the Engineer, amount of time. All asphalt laboratories shall also be equipped with all applicable equipment listed in ALDOT-349.

106.04 Contractor's Statement of Material Sources.

Before work on any contract is started, the Contractor may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials proposed to be used in the construction of the work, together with samples which may be subjected to the tests provided in the contract to determine their quality and fitness for the work.

106.05 Handling and Storage of Materials.

(a) Handling Materials.

All materials shall be handled in such a manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials, intended for incorporation in the work, as loaded and the quantities as actually received at the place of operations.

(b) Storage of Materials.

Materials shall be so stored as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right of way may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner or lessee, and if requested by the Engineer copies of such written permission shall be furnished him. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of topsoil, or to other materials salvaged from the work.

106.06 Unacceptable Materials.

All materials not conforming to the requirements of the Specifications shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

In case of failure by the Contractor to comply promptly with any order by the Engineer to remove rejected materials, the Engineer shall have authority to have such rejected materials removed by other means and to deduct the expense of such removal from any monies due or to become due the Contractor.

106.07 Department Furnished Material..

The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department. Department furnished materials will be delivered to or made available to the Contractor at locations specified in the contract.

The cost of handling and placing all materials after they are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any monies due him to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery, and for any demurrage charges.

106.08 Rights In and Use of Materials Found on the Right of Way.

The Contractor, upon his written request and written approval of the Engineer, may use on the project, sand, gravel, rock, or other materials determined suitable by the Engineer as may be found in the limits of the regular excavation. The Engineer will make a study of the Contractor's request and shall submit to the Contractor a written statement of the guidelines under which the request is approved. This statement shall include a detailed analysis of the pay item, or items, under which the Contractor will receive payment for the work performed. The intent is not to preclude payment for both the item of removal and the item under which the materials are used, if, in the opinion of the Engineer payment under both items are justified, but to allow the Department to share in any savings realized by the Contractor in the use of such materials.

The Contractor shall not excavate or remove any material from within the highway location that is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Any coal or other valuable mineral found within the construction limits as defined by the slope and grade lines considered to be unsuitable for reuse on the project shall be removed by the Contractor. In no case shall any coal or other mineral be removed from outside the slope lines or below subgrade except that removed as unsuitable material as directed by the Engineer (not to exceed 30 inches {750 mm} below subgrade), unless otherwise shown by plan details or with written authorization of the Transportation Director. The Contractor shall assume full responsibility and liability for insuring that any legal rights due the holder of the mineral rights are satisfied prior to the disposition of any mineral. By

agreement with the owner of the mineral rights, the Contractor may dispose of this material by direct sale and payment of royalty to the owner or by stockpiling for immediate removal by the owner. The Contractor shall hold the State harmless in all matters pertaining to the disposition of any mineral.

106.09 Quality Control and Quality Assurance (QC/QA) Requirements for Hot Mix Asphalt (HMA) Pavement.

(a) General.

The following modifications apply only to the materials and work performed under Sections 327, 410, 420, 423 and 424.

In all cases, the Department's testing will be separate from the Contractor's testing and both shall be conducted by certified technicians.

All **Quality Control** aspects of this provision shall be the responsibility of the Contractor. Quality Control is defined as the activities that are related to the production of Hot Mix Asphalt Pavement which meet all the requirements of the Specifications, including mix design, process control testing, sampling and acceptance testing (when so designated by the Department) for determination of Pay Factors, and necessary adjustments to the production process.

All **Quality Assurance** aspects of this provision shall be the responsibility of the Department and will be accomplished in the following ways:

1. By conducting assurance/verification testing, on a random basis, of independent samples obtained by the Department, at a frequency of one or more per day;
2. By periodically observing tests performed by the Contractor;
3. By monitoring required Contractor control charts exhibiting test results of control parameters.

All Superpave Gyratory Compactors shall have their angle of gyration verified by the Engineer following the procedure in AASHTO T 344, "Standard Method of Test for Evaluation of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading". This includes all design, quality control, and quality assurance SGCs. The compactors shall tilt the specimen molds at an average internal angle of 20.2 ± 0.35 mrad (1.16± 0.02 degrees).

(b) Quality Control.

The Contractor shall provide and maintain a quality control system that will provide reasonable assurance that all materials, products, and completed construction submitted for acceptance conform to contract requirements whether manufactured or processed by the Contractor or procured from subcontractors or vendors. Quality control managers, laboratory technicians and roadway technicians will be certified by the Department as outlined in ALDOT-374, "Certification Requirements for Hot Mix Asphalt Technicians". This quality control system shall conform to ALDOT-370, *Quality Control and Quality Assurance Procedures and Responsibilities for Asphalt Plant Mix Production*.

The sampling and testing frequencies shall conform to the requirements given in Table 1 for a pay item when the accumulated amount of asphalt mix placed for that pay item exceeds 250 tons {250 metric tons}. The accumulated amount of asphalt mix shall be the current total amount of asphalt mix that has been placed beginning from the start of construction. The sampling and testing frequencies given in Table 1 may be waived by the Area Materials Engineer and the asphalt mix may be accepted by visual observation for a maximum accumulated asphalt mix placement quantity of 250 tons {250 metric tons} or less for any individual pay item. The Engineer will record the results of the acceptance of the asphalt mix on form BMT-16 if sampling and testing is not required.

TABLE I — SECTION 327 E and 420 MIXES
SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS

Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1. Asphalt Content *	ALDOT Sample = 55 lb {25 kg} Split into 2 equal samples Contractor Sample = 55 lb {25 kg} Split into 2 equal samples	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 +++	1 per day per LOT	++ 1 per 700 tons
2. Mixture Gradation * *		AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	1 per day per LOT	++ 1 per 700 tons
3. Asphalt Draindown	12 lb {5 kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required

* See ALDOT-370 "Quality Control and Quality Assurance Procedures and Responsibilities for Asphalt Plant Mix Production".

* * If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.

\+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.

++ One sample for each 500 tons {500 metric tons} for Section 420 mixes.

Note: The testing increment shall have a 150 ton buffer between each increment.

+++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight {mass} and percent weight {mass} loss is computed and produced on hard-copy output.

TABLE I (*CONT'D.*) — SECTION 423 MIXES (*STONE MATRIX ASPHALT*)
SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS

Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1. Asphalt Content *	ALDOT Sample = 90 lb {40 kg} Split into 2 equal samples Contractor Sample = 90 lb {40 kg} Split into 2 equal samples	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 ++++	1 per day per LOT	++ 1 per 700 tons
2. Maximum Specific Gravity *		AASHTO R 97 & ALDOT-210	+Loaded Truck	AASHTO T 209 (Flask determination with dry back)	1 per day per LOT	++ 1 per 700 tons
3. Air Void Content & VMA *		AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-370 & ALDOT-307	1 per day per LOT	++ 1 per 700 tons
4. Mixture Gradation * *		AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	1 per day per LOT	++ 1 per 700 tons
5. Retained Tensile Strength Note: The TSR test is not required for any pay item less than a full lot.	25 lb {12 kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-361	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter
6. Mat Density *		ALDOT-210	Roadway	ALDOT-222 & ALDOT-350		As per Contractor's QC plan (ALDOT-370)
				ALDOT-403 AASHTO T 166 Method A AASHTO T 275 AASHTO T 331	°° 1/3000 lane feet/lift {1/900 lane m/lift	
7. Clay Content	Adequate Quantity	AASHTO R 90	Aggregate Stockpiles	AASHTO T 176	As required	As required
8. Asphalt Draindown	12 lb {5 kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required

* See ALDOT-370 "Quality Control and Quality Assurance Procedures and Responsibilities for Asphalt Plant Mix Production".

* * If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.

°° Cores shall be taken by the Contractor and the density will be determined by the Department.

\+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.

++ The sample shall be one set of three Marshall samples or one set of two gyratory samples +++.

Note: The testing increment shall have a 150 ton buffer between each increment.

+++ When slag is used as an aggregate in the mixture, four Marshall samples or three gyratory samples shall be compacted. The test result the furthest away from the average of the four test results shall be discarded and the remaining three test results shall be averaged for use in the computation of air voids.

++++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight {mass} and percent weight {mass} loss is computed and produced on hard-copy output.

TABLE I (*CONT'D.*) SECTION 424 MIXES (*SUPERPAVE*)

SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS

Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1.Asphalt Content *	ALDOT Sample = 135 lb {60 kg} Split into 2 equal samples Contractor Sample = 135 lb {60 kg} Split into 2 equal samples	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 ++++	1 per day per LOT	++ 1 per 700 tons
2. Maximum Specific Gravity *		AASHTO R 97 & ALDOT-210	+Loaded Truck	AASHTO T 209 (Flask determination with dry back)	1 per day per LOT	++ 1 per 700 tons
3. Air Void Content & VMA		AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-384 ALDOT-388 ALDOT-370	1 per day per LOT	++ 1 per 700 tons
% G_{mm} @ N_d *					As needed	
4. Mixture *** Gradation & Dust to Asphalt Ratio *		AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	1 per day per LOT	++ 1 per 700 tons
5. Retained Tensile Strength Note: The TSR test is not required for any pay item less than a full lot.	25 lb. {12 kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT-361	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 randomly for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter
6. Mat Density *		ALDOT-210	Roadway	ALDOT-222 & ALDOT-350		As per the Contractor's QC plan (ALDOT-375)
				ALDOT-403 AASHTO T 166 Method A AASHTO T 275 AASHTO T 331	°° 1/3,000 lane feet/lift {1/900 lane m/lift}	
7. Fine Aggregate Angularity * * FAA Note: The FAA test is not required for any pay item less than a full lot.	Adequate quantity to run AASHTO T 304, Method A or ASTM C 1252,Method A	AASHTO R 90	+Loaded Truck	AASHTO T 304, Method A Or ASTM C 1252, Method A	1 for the first full lot (2,800 tons {2,800 metric tons}) and 1 for the next 10,000 tons {10,000 metric tons} and 1 for each additional 20,000 tons {20,000 metric tons} or portion thereafter	1 for the first full lot (2,800 tons {2,800 metric tons}) and 1 randomly for the next 10,000 tons {10,000 metric tons} and 1 randomly for each additional 20,000 tons {20,000 metric tons} or portion thereafter
8. Clay Content	Adequate quantity	AASHTO R 90	Stockpile	AASHTO T 176	As required	As required
9. Asphalt Draindown	12 lb {5kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required
10. Split Tensile *X*	35 lb. {17 kg}	AASHTO R 97 & ALDOT-210	+Loaded Truck	ALDOT 361 (Report the Unconditioned Sample for Split Tensile)	N/A	1 for the first full lot and 1 randomly for each additional 10,000 tons thereafter

TABLE I (*CONT'D.*) SECTION 424 MIXES (*SUPERPAVE*)
SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS

* See ALDOT 370 "Quality Control and Quality Assurance Procedures and Responsibilities for Asphalt Plant Mix Production".
** In virgin mixes, the sample may be taken from the cold feed conveyor.
*** If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.
°° Cores shall be taken by the Contractor and the density will be determined by the Department.
\+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.
++ The sample shall be one set of two gyratory samples+++.
Note: The testing increment shall have a 150 ton buffer between each increment.
+++ When slag is used as an aggregate in the mixture, three gyratory samples shall be compacted. The test result the furthest away from the average of the three test results shall be discarded and the remaining two test results shall be averaged for use in the computation of air voids.
++++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight {mass} and percent weight {mass} loss is computed and produced on hard-copy output.
X Testing in accordance with the requirements given in Section 410 is only required for Job Mix Formulas that have greater than 25 % RAP. Mix shall be tested by an AASHTO accredited laboratory.

(c) Quality Assurance.

1. Acceptance Procedures.

All materials will be evaluated for acceptance and payment through the Department's Acceptance Procedures specified herein. The Department will be responsible for determining the acceptability and pay factor of the construction and materials incorporated therein.

The Department will utilize the Contractor's QC System test results for liquid asphalt binder content and laboratory compacted air void content for pay purposes except where:

a. The Department's Quality Assurance testing, as described in Item 3 below and Subarticle 410.08, does not validate the quality of the material.

b. QC sampling and testing was not performed in accordance with specified procedures.

The Department will determine the sample locations.

The sampling and testing frequencies shall conform to the requirements given in Table 1 for a pay item when the accumulated amount of asphalt mix placed for that pay item exceeds 250 tons {250 metric tons}. The accumulated amount of asphalt mix shall be the current total amount of asphalt mix that has been placed beginning from the start of construction. The sampling and testing frequencies given in Table 1 may be waived by the Area Materials Engineer and the asphalt mix may be accepted by visual observation for a maximum accumulated asphalt mix placement quantity of 250 tons {250 metric tons} or less for any individual pay item. The Engineer will record the results of the acceptance of the asphalt mix on form BMT-16 if sampling and testing is not required.

All conforming and nonconforming inspections and test results will be monitored in accordance with ALDOT-370 and shall be recorded on approved forms and charts which shall be kept up to date and complete and shall be available at all times to the Department during the performance of the work. Only those tests designated by the Department in advance as acceptance tests will be utilized in the computation of pay factors. Test properties shall be charted on forms that are in accordance with the applicable requirements of the Department. A copy of each chart and form to be used by the Contractor will be furnished by the Department. The Contractor shall furnish his own supply of the charts and forms. The Contractor or Producer may design their own forms and charts; however, these must be approved by the Engineer prior to their use.

A LOT is normally defined as 2,800 tons {metric tons} for Section 327, 423 and 424 mixes, and 2,000 tons {metric tons} for Section 420 mixes, consisting of four QC test sets of laboratory tests (liquid asphalt binder content and laboratory air voids or gradation), unless specifically stated otherwise in this item or elsewhere in the specifications. A LOT will usually consist of at least four density tests; however, a LOT may have fewer than four density tests. The Engineer will round a testing increment or a LOT to the nearest truckload of material.

A LOT lasting longer than thirty calendar days or a LOT with inactivity for longer than 30 calendar days will be terminated. Mix produced after the completion of the last full LOT, a terminated LOT, and small production projects will be evaluated and pay factors computed and may be accepted on the basis of less than four laboratory tests (liquid asphalt binder content and laboratory air voids or gradation).

Each LOT will be accepted on the basis of the actual number of test sets run for that LOT. If the production process is considered out of control (any individual test result for asphalt content, gradation (single sieve), or air voids has a pay factor equal to 0.80 computed from the "1 Test" row

in Table II and Table III, or the "1 Test" column in Table VI, of Subarticle 410.08 whichever is appropriate), production shall be suspended and corrections made as outlined in Subarticle 410.08. Gradation pay factors are normally computed on each screen tested and then averaged, however, if any individual screen has a pay factor of 0.80 (before being averaged with the other screen(s)), the process is considered out of control.

The Contractor may voluntarily terminate a LOT when the pay factor will be less than 0.90 when calculated using the one test row of Table II and Table III and the one test column of Table VI in Section 410. If the Contractor terminates a LOT, production shall be suspended and corrections made as outlined in Subarticle 410.08. The voluntary termination of a LOT may only be done once per pay item, per project.

All sampling, testing and computations for a LOT will be completed and pay factors provided the Contractor as soon as possible.

All sampling and testing of materials, including frequency of samples and tests for the Contractor's Quality Control and the Department's verification, shall be performed in strict conformance with the Department's Testing Manual as modified in Table I. This Manual (available on the ALDOT Internet Site) contains guidance for sampling and testing procedures from AASHTO, ASTM, and ALDOT procedures.

2. Acceptance or Rejection.

The decision of the Engineer will be final as to the acceptance, rejection, or acceptance at an adjusted payment of each LOT. Rejected LOTS shall be removed at no cost to the Department and replaced at the contract unit bid price.

3. Sampling of Lots and Sublots.

It is the intent of these specifications that each LOT (for mixture testing) and each SUBLOT (for mat density testing) will meet specification requirements at the time of initial evaluation. No resampling or retesting (other than referee testing described below) will be allowed. The Department will, however, perform at least one liquid asphalt binder content, one maximum specific gravity, one mixture gradation, and one set of laboratory compacted samples for air void content tests per day per Lot, as specified in Table I, to verify the Contractor's test results. If the Contractor is not required to perform a test that day (the tonnage calculated by the random number is not reached), the Department will not run a verification test. The Department will perform a verification test for each LOT, even where there is more than one LOT per day.

The Contractor will be notified by the Engineer at the point in production to procure mixture acceptance samples. The Contractor shall sample the mixture and split it into two samples: the Contractor's primary sample and a referee sample. The portions of mixture for the referee sample shall be bagged, labeled, and stored for testing, if required. All referee samples will be kept by the Department until they are tested (if required).

The Contractor shall obtain a verification testing sample from each LOT each day for testing by the Department. The verification testing samples shall be taken at locations directed by the Engineer. These locations will be different from the Contractor's mixture acceptance sample locations. The Contractor may take half of each sample for verification testing. The Department will compare the verification sample to the closest (in tonnage) Contractor's primary sample. The sampling of Hot Mix Asphalt is outlined in ALDOT-380, Forms and Examples for Sampling and Computing Pay Factors for Hot Mix Asphalt.

4. Testing and Lot Verification.

Air voids shall be computed on the Contractor's sample by using the running average of the Contractor's last four maximum specific gravities. If slag is used as an aggregate in the mixture, the running average of the Contractor's four most recent determinations for the bulk specific gravity of the compacted mixture shall be used in the computation of the air voids for the Contractor's sample. The calculation of the running averages of both maximum specific gravity and bulk specific gravity shall start with the first LOT. The test strip is independent of the LOTs. Air voids shall be computed on the Department's sample by using the Department's individual maximum specific gravity and bulk specific gravity. The Department and the Contractor shall compare test results with each other for the above mentioned testing increments. If there are no differences or if the differences are within the tolerances listed in Tables V or VI, Section 410, for each parameter, no further testing and analysis will be necessary and the Contractor's test values will be used in the computation of the appropriate LOT pay factor.

If the Contractor's air voids do not compare with the Department's test results, the Contractor shall re-compute test results using the individual maximum specific gravity for that particular testing increment and re-compare with the verification test result. If the results compare within the tolerances in Table V, Section 410, using the individual maximum specific gravities, no further testing will be required and the Contractor's running average of the last four maximum specific gravities will be used to compute air voids for pay factor determination.

Also, if the Contractor's air voids do not compare with the Department's test results, and the Contractor is using slag as an aggregate, the Contractor shall re-compute test results using the individual bulk specific gravity for that particular testing increment and re-compare with the verification test result. If the results compare within the tolerances in Table V, Section 410, using the individual bulk specific gravity, no further testing will be required and the Contractor's running average of the last four bulk specific gravities will be used to compute air voids for pay factor determination.

If the results of the Department's verification test and the Contractor's test do not compare within the tolerances in Tables V or VI, Section 410, but yield the same pay factor for the LOT when the Department's result is substituted for the Contractor's result, no further testing will be required. Where the Contractor's test results and the Department's test results do not compare and cannot be resolved by the above mentioned methods but the pay factor dispute is between 1.00 and 1.02 the Contractor may elect to accept the 1.00 pay factor and waive referee testing.

When differences between test results of the verification samples are not within the tolerances listed in Tables V or VI, Section 410, and cannot be resolved by the above mentioned methods, referee testing will be required.

All referee samples will be tested by the Bureau of Materials and Tests, Central Laboratory, 3704 Fairground Road, Montgomery, AL 36110. The Bureau of Materials and Tests Central Laboratory is an AASHTO accredited laboratory (see AASHTO R 18, Recommended Practice for Establishing and Implementing a Quality System for Construction Materials Testing Laboratories).

5. Referee Testing

a. Laboratory:

All testing increments of the referee samples for the entire LOT shall be tested in the Bureau of Materials and Tests Hot Mix Laboratory for the pay factor parameter(s) (liquid asphalt binder content, laboratory compacted air voids, or gradation) in question. The Contractor's results (using the individual air voids and maximum specific gravities) will be compared to the Bureau of Materials and Tests results (using Materials and Tests individual bulk and maximum specific gravities) for each testing increment in the LOT. When the Contractor's results and the Bureau of Materials and Tests results are within the tolerances listed in Tables V or VI, Section 410, the Contractor's results will be used. When the Contractor's results are not within the tolerances listed in Tables V or VI, Section 410, the Bureau of Materials and Tests Central Laboratory results will be used for final pay factors. The Bureau of Materials and Tests Central Laboratory will record the Contractor's field results and the Central Laboratory's results of the parameter(s) in question on form BMT-135.

For each testing increment these results, either the Contractor's or the Bureau of Materials and Tests', will be used in the computation of the appropriate LOT pay factor.

Should differences between test results, that are not within the tolerances listed in Table V or VI, Section 410, for liquid asphalt binder content, air voids, or gradation continue for two consecutive days, operations shall be halted until testing discrepancies can be resolved. The Bureau of Materials and Tests will monitor testing procedures by Department and Contractor technicians until consistent test results are achieved.

b. Cores:

If the Contractor believes that the core density values determined by the State are in error, the Contractor shall notify the Area Materials Engineer in writing that referee testing is requested. Using the original cores, the Area will again determine the densities of the cores in question using a technician different from the technician who originally determined the core density. If these new densities result in a different pay factor, the new pay factor shall be applied to the tonnage in question (this may increase or decrease the Contractor's pay adjustment).

6. Adjusted Payment for Deficiencies.

The payment for each LOT will be adjusted on the basis of acceptance test results in accordance with the requirements given in this Section. Accurate records shall be kept of the quantity (tonnage) of plant mix in each LOT.

106.09 Quality Control and Quality Assurance (QC/QA) Requirements for Hot Mix Asphalt (HMA) Pavement.

Pay factors shall be determined for each LOT from the values given in Tables II, III, IV, and VI, Section 410, in accordance with the following:

Pay Factor For:	Mix 327	Mix 420	Mix 423	Mix 424
Air Voids	N/A	N/A	Table II	Table III
Asphalt Content	Table II	Table II	Table II	Table III
Mat Density	N/A	N/A	Table IV	Table IV
Gradation	N/A	Table VI	N/A	N/A

The lowest numerical pay factor in a Lot will be applied to the contract price for the total tonnage {metric tonnage} in the LOT. This will result in an adjustment to the compensation for the Lot that will be shown in a separate line item on the payment estimates.

Pay factors above 1.00 will not be applied to mixes that are tested on fewer than three characteristics or when there are less than four laboratory tests (percent liquid asphalt binder and laboratory air voids or gradation) per characteristic; it is not necessary to obtain four roadway densities to obtain a pay factor above 1.00. When the pay factor is calculated to be greater than 1.00, a pay factor of 1.00 will be applied.

Pay factors above 1.00 will not be applied to mixes where the roadway density requirement has been lowered below 94%.

(d) Adjustment Period.

During start-up operations, an adjustment period (test strip) as described below shall be required when producing a new job mix formula. The purpose of the adjustment period will be to permit the Contractor to adjust his production process and for Contractor QC personnel and ALDOT QA personnel to calibrate and coordinate their testing procedures. The Contractor has the option of running a test strip or waiving the test strip, if the proposed job mix formula has been produced satisfactorily on previous projects. The waiver of a test strip shall be in writing to the Project Manager and the Area Materials Engineer prior to any production and placement of the previously produced job mix design. The Contractor assumes the risk of milling and relaying unacceptable mix with no additional compensation if the test strip is not utilized.

A test strip of not more than 500 tons {500 metric tons} shall be constructed. If the placement of a test strip is not completed the same day it is begun, the Contractor shall construct a new test strip. Production shall stop until the Contractor has completed one liquid asphalt binder content, one air void content, and four mat density tests for mixes other than 327 and 420. For 327 and 420 mixes the Contractor shall complete one liquid asphalt binder content and one gradation. The pay factors for liquid asphalt binder content, air void content, and gradation will be calculated using the one test row of Table II and Table III and the one test column of Table VI, and the pay factor for mat density will be calculated using the four test column of Table IV in Section 410. The production point at which the mix shall be sampled shall be determined by the Contractor. This sample does not have to be randomly selected, but should be representative of the mix produced. Contractor mat density tests shall be performed with non-destructive density testing devices, meeting the requirements of Section 306, which have been calibrated for the layer being placed according to ALDOT-222, ALDOT-350, or Section 306. The Contractor shall cut cores at these locations and immediately turn the cores over to the Department for density measurements and determination of the pay factor. The Department will conduct the same tests for verification at the same time the Contractor is conducting his tests. If a pay factor of less than 1.00 is obtained using the one test row of Table II and Table III and the one test column of Table VI, and using the four test column of Table IV in Section 410, a second test strip consisting of 200 tons {200 metric tons} shall be constructed. If a pay factor of less than 1.00 is obtained using the one test row of Table II and Table III and the one test column of Table VI, and using the four test column of Table IV in Section 410 in the second test strip, additional 200 ton {200 metric ton} test strips shall be constructed until pay factors are equal to 1.00, at which time production can begin. A test strip is determined to be complete when the results of the tests are known.

The Engineer may require any test strip to be removed and replaced at no cost to the Department if the pay factor determined from the four test row for mat density or the one test row for other tests is 0.80. For actual payment purposes, a pay factor of 1.00 will be used for all first and second test strips allowed to remain in place. Pay factors will be applied to the third and all subsequent 200 ton test strips at the average of the computed rate (using the one test row) and 1.00.

SECTION 107
LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 Laws to be Observed.

The Contractor shall keep fully informed of all Federal and State laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by himself or his employees.

The Contractor shall provide for the safety of his employees and the public along with protection of property in the performance of the work. Particular reference is made to the Federal Occupation Safety and Health Act Title 29, CFR Part 1926 (Published December 16, 1972, and all applicable amendments) for construction work and Part 1910 (Published May 29, 1971, and all applicable amendments) for general industry standards for those materials not covered in Part 1926, which is a condition of the contract and shall be a condition of any subcontract entered into pursuant thereto.

All ocean shipping of materials and products used on Federal-aid highway projects shall comply with the requirements of Part 381, Title 46, CFR. The prime Contractor shall submit copies of all commercial ocean bills of lading to the Maritime Administration in Washington at the following address:

Chief, Division of National Cargo MAR 822
Maritime Administration
400 7th Street, S.W.
Washington, DC

The Contractor's letter of transmittal shall show his address, the project number, project location, and the type materials involved.

107.02 Permits, Licenses and Taxes.

The Contractor shall procure all permits, and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

107.03 Patented Devices, Materials, and Processes.

If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the Surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the State for any costs. expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the prosecution or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit.

The right to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality in which the work is done.

When an individual, firm or corporation is authorized through a duly executed permit from the Department, the Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, the Contractor shall make in an acceptable manner, all necessary repairs due to such openings and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 Federal Aid Participation.

When the United States Government participates in the cost of the work covered by the contract, the work shall be under the supervision of the State but subject to the inspection and approval of the proper officials of the United States Government and in accordance with the applicable Federal Statutes and rules and regulations made pursuant thereto (Reference Title 23, U.S. Code as amended).

Such inspection shall in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party hereunder.

The Contractor and Subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR 26 in the award and administration of USDOT assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy, as the ALDOT deems appropriate.

107.06 Sanitary, Health and Safety Provisions.

The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and local Board of Health, or of other bodies or tribunals having jurisdiction.

Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The Contractor shall not require any worker to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his health or safety.

107.07 Public Convenience and Safety.

(a) Care of Traffic.

The Contractor shall at all times conduct his work so as to insure the least possible obstruction to traffic. The safety and convenience of the general public and residents along the highway shall be provided for by the Contractor as specified under Article 104.04.

The Contractor shall have no greater length or amount of work under construction than he can prosecute properly with due regard to the rights of the public.

The Contractor shall immediately clean up any spillage resulting from hauling operations along or across any public traveled way.

The Contractor shall notify the Engineer before starting any construction work that might inconvenience or endanger traffic and shall make such arrangements for the safety and convenience of traffic as may be required by the Engineer.

(b) General Public.

In general, vehicles of the traveling public shall have preference over those of the Contractor to the end that vehicles of the traveling public shall not be unduly delayed for the convenience of the Contractor. When so directed the Contractor shall station flagmen, whose sole duties shall consist of directing traffic safely and expeditiously through or around the work.

Materials and equipment on the right of way shall be so placed as to insure minimum danger to the traveling public.

Where traffic passes through construction, a suitable width shall be maintained level and smooth to provide satisfactory passage. This width shall be watered or treated with dust control agents as directed to prevent dust nuisance. Soil aggregate, aggregate, or other suitable material shall be spread where and as directed by the Engineer to facilitate movement of traffic over soft portions of this width. Traffic shall be maintained over or around structures and culverts.

(c) Cooperation with Fire Department.

The Contractor shall arrange his work so that there will be no undue or prolonged blocking of business establishments. Fire hydrants shall be kept accessible at all times. In the absence of local ordinances, no obstruction shall be placed within 15 feet {5 m} of a fire hydrant. The Contractor shall notify the Chief of the Fire Department in writing 24 hours before it becomes necessary to block a cross street.

(d) Compensation.

The Contractor shall comply with all the requirements for public safety and convenience listed in this Article without extra compensation, except for the items of temporary surface material, Section 430, which shall be paid for at the contract unit price, or as extra work if the contract does not contain unit prices for these items.

107.08 Railway-Highway Provisions.

(a) Notification.

No work of any character shall be commenced on the railroad right of way until the railroad company has been duly notified by the Contractor in writing (with a copy forwarded to the Engineer)

of the date he proposes to begin work and until an authorized representative of the railroad company is present, unless the railroad company waives such requirement.

(b) Inspection By Railroad Company.

All changes in approved plans and all work performed by the Contractor involving railroad crossings shall be subject to the inspection and approval of the chief engineer of the railroad company, or his authorized representative. Any precautions considered necessary by said chief engineer to safeguard the interests of the railroad company shall be taken by the Contractor without extra compensation. The State shall not be held responsible for delay to the Contractor's work due to any delay in securing such approval of construction features or changes therefrom; and any additional cost incurred by the Contractor due to such delay shall be considered as completely covered by the contract unit prices for the various items of work involved in the contract. For such delays, working days will not be charged on working day contracts, and appropriate time extensions will be granted for contracts on a calendar day or date basis.

If work remains to be completed after the expiration of contract time the Contractor shall reimburse the Department for all of the costs charged by the railroad company for the inspection and monitoring of the remaining work.

(c) Temporary Grade Crossing.

The Contractor shall make all arrangements with Railway Companies for the establishment of any temporary crossing to be used by the Contractor for transporting materials and equipment across their tracks. Permission for such a crossing must be obtained from the Railway Engineer prior to establishment of the crossing. All costs for installation, maintenance, any necessary watching and flagging thereof, and the removal shall be borne by the Contractor. The Contractor shall so plan his work so as not to delay Railroad Company operations.

107.09 Construction in Wetlands and Over or Adjacent to Waters of the United States.

(a) General.

Section 404 of the Federal Water Pollution Control Act of 1972 sets forth certain restrictions and requirements for materials placed in waters of the United States that are applicable to construction over or adjacent to waters of the United States. The Department will obtain any special permits necessary for the construction of the project within the scope of the design details of the contract plans and the specifications for the project. Generally, compliance with the above law can be accomplished by following the plan details along with adhering to the Specification requirements of Articles 107.13, 107.20, 107.21, 107.22, 107.23, and Section 665, utilizing the methods outlined in Section 665.

The Contractor will be required to operate within the limits of any special permit issued for the construction work on a project.

Attention is directed to the fact that construction methods or work in the flood plain area varying from plan details, specifications and permit proposed strictly for the convenience of the Contractor will require additional permit clearance. Any additional clearance, permit, etc. necessary to comply with the above noted laws shall be the sole responsibility of the Contractor and clearance for such work must be in the Engineer's hands before he will allow such work to proceed.

(b) Work Over Navigable Waters.

In addition to the provisions of Subarticle (a) above, all work over or on navigable waters shall be so conducted that free navigation of waterways will not be interfered with and that the existing navigable depths will not be impaired except as allowed by permit issued by the U.S. Coast Guard and/or U.S. Army Corps of Engineers, as applicable. The Department will obtain the necessary permit for the construction of the project within the scope of the design details shown by the plans, any special conditions will be noted on the plans or included in the contract documents. Should the Contractor, for his convenience, wish to use construction methods or perform work outside of the scope of the permit obtained by the Department, he shall be solely responsible for obtaining any additional work permit from the appropriate authority.

(c) Special Conditions

Should the required work be permitted under a US Army Corps of Engineers “Nationwide Permit” or “Individual Permit”, the Contractor shall abide by all the applicable requirements for each type of

permit. Both types of permits are subject to the general requirements given in 33 CFR Part 330 “Nationwide Permit Program”.

A copy of the permit and its requirements will be included in the Construction Best Management Practices Plan (CBMPP) and made available for review during the project advertising period. A copy may be obtained from the ALDOT Office Engineer, and the successful bidder will be given a copy.

107.10 Barricades and Warning Signs.

The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices; shall provide qualified flagmen where necessary to direct traffic; and shall take all necessary precautions for the protection of the work and safety of the public. Highways or parts of the work closed to traffic shall be protected by effective barricades; obstructions shall be delineated; suitable warning signs shall be provided to properly control and direct traffic. All signs, barricades, etc. shall be reflectorized in an approved manner and if directed by the Engineer, supplemented with warning lights or illumination to increase their effectiveness.

The Contractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be placed and maintained in accordance with the plans furnished. No signs, barricades, lights or other protective devices shall be dismantled or removed without permission of the Engineer.

All barricades, warning signs, lights, temporary signs, and other protective devices shall conform with the MUTCD.

107.11 Use of Explosives.

(a) General.

It is the intent of this Article to provide general guides for the handling and use of explosives. The Contractor shall use all precaution, control, and safety features outlined by this Article as well as any additional requirements felt necessary to insure the safety of life or property in the area of operations.

(b) Control.

When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. Blasting operations shall be performed under the most skilled supervision. Where necessary and at any point of special danger, the Contractor shall use suitable mats or other approved methods to smother his blast. No loaded hole shall be left unattended.

Where blasting is to be done in streams, the Contractor shall notify the Conservation Department sufficiently in advance to permit on-the-site observation by Conservation Department personnel at the time of the blast.

Where blasting is performed in urban areas or areas that are heavily populated, extreme care shall be taken to minimize the amount and degree of ground vibration, noise, overpressure, and flying debris.

(c) Storage of Explosives.

All explosives shall be stored in a safe manner, in compliance with local, State, and Federal laws and ordinances.

(d) Warning of Blasting.

The Contractor shall warn each utility company having structures in proximity to the blasting area of his intentions to use explosives. Such warning shall be sufficiently far in advance of blasting to enable the company to protect its property. Such warning, however, shall not relieve the Contractor of responsibility for any damage resulting from blasting. The Contractor shall erect suitable signs on all roads in the immediate vicinity of blasting operations, warning of blasting activity. The signs shall also include warning that all portable radio transmitters should be turned off while in the vicinity. If required, the Contractor shall control traffic by use of flagmen and guards in the danger zone of blasting.

In all urban areas, and other heavily populated areas when designated by the plans or proposal, the Contractor or his insurer shall conduct a pre-blast survey of all structures to determine the existing or preblasting condition, such survey being a written description with special emphasis on defects and documented with appropriate photographs. This survey is intended to serve as a basis of comparison for any post-blast claims that may arise. The Contractor or his insurer shall obtain the services of a competent vibration or seismologist consultant to conduct both blast noise, vibration and overpressure surveys at periodic intervals during the progress of the blasting operations. It is the intent of this Section

to serve as protection to the Contractor to minimize the post-blast claims and not to require unwarranted work. The Contractor shall use every precaution available and practical to minimize ground vibration, noise and overpressure.

The Contractor and his surety shall indemnify and save harmless the State, the Director and all its representatives from all claims for damages arising out of the use, transportation, or storage of explosives.

107.12 Protection and Restoration of Property, Landscape and Utility Facilities.

(a) Property and Landscape.

The Contractor shall not enter upon private property for any purpose without permission first being obtained from the owners and lessees. The Contractor shall be responsible for preservation of all public and private property, utilities, monuments, highway signs, etc. on or adjacent to the highway. He shall not remove, injure, or destroy without proper authority trees or plants that are shown on the plans or ordered by the Engineer to remain on or adjacent to the right of way. The Contractor shall protect from disturbance all land markers until an authorized agent has witnessed or referenced the locations and shall not move them until directed. The Contractor shall notify the Engineer immediately upon discovery of artifacts or other articles of possible archeological value revealed by his operations, and shall carefully preserve them and prevent disturbance of the site until the Engineer has had opportunity to arrange appropriate disposal. Highway signs and markers shall be carefully removed as the grading operations progress and stored in a manner to keep them clean and dry.

When the work affects the foundation support of any building along the work, the Contractor shall give property owners and lessees direct and sufficient notice to support such buildings. The Contractor and his surety shall hold the State, the County, the Municipality, the Director, and the Engineer harmless from any damage resulting from undercutting any such buildings.

The Contractor shall be solely and exclusively responsible for any and all restoration, repair or replacement of public and private property due to, caused by, or as a result of any act, omission, negligence or misconduct of the Contractor. The Contractor shall provide an appropriate remedy as approved by the Engineer.

Failure on the part of the Contractor to satisfy the requirements given in this Subarticle, shall result in the Engineer affecting an appropriate remedy at the Contractor’s expense.

(b) Utilities.

1. Where the Contractor's operations are adjacent to utilities or other property, damage to which might result in expense, loss, or inconvenience, work shall not be begun until all arrangements necessary for property protection has been made.

The Contractor shall be responsible to the owners and operators of such property for any damage, loss, or inconvenience. He and his surety shall defend any suits, actions, or claims of any character brought due to injuries or damages resulting from performance of the work under this contract. If required by the Director, he shall furnish a certificate of his public liability and property damage insurance to each utility company or individual owning or operating any of the properties affected in the guarantee of this responsibility.

2. The Contractor shall cooperate with the owners of any utilities in their removal and rearrangement operations so that the utility companies may conduct their operations in a reasonable manner with a minimum of duplication of the work and interruption of services. The Contractor will be furnished by the Department information that is reasonably available in regard to existing or proposed new utilities, but the accuracy of such information is not guaranteed by the Department. It shall be the Contractor's responsibility to secure information necessary for proper handling and coordination of utility work. He shall give at least 48 hours written notice to owners or operators of all properties that may be affected by his operations before beginning such operations. He shall not hinder or interfere with utilities in protection or operations of the properties. When such properties are endangered, the Contractor at his own expense shall maintain flagmen or watchmen and other necessary precautions to avoid interruption of service or danger to life or property. He shall promptly replace, restore, or make good in an acceptable manner any injury or damage caused by his operations.

3. In event of interruption to water or utility services as a result of the Contractor's operations, he shall notify promptly the proper authority and cooperate with the said authority in restoration of service as promptly as possible.

107.13 Woodland Protection, Conservation, Abatement of Water Pollution and Quarantine Regulations.

The Contractor shall comply with all regulations of the State Fire Marshal, Conservation Department, Forestry Department, or regulatory body governing the protection of forests and other conservation areas, and the carrying out of work within such areas, and shall observe all laws and regulations with respect to the performance of work in such areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, sanitary facilities, and other structures in accordance with the requirements of the Forest or Conservation supervisor.

It shall be the Contractor's responsibility to contact the local representatives of the Alabama Department of Agriculture and Industries, and the U.S. Department of Agriculture in order to advise himself, his agents, and his employees regarding quarantined areas and quarantine restrictions affecting his organization while operating within, from or through such areas. Special attention is directed to soil and/or machinery treatment which may be required when operating in, from or through quarantined areas. A list of agents of these two Departments will be furnished the Contractor upon request prior to beginning of his construction or maintenance operations. The State will not be liable for any additional compensation for extra costs arising from quarantine restrictions or penalties.

The Contractor's attention is directed to the requirements for stormwater management as noted in Article 107.21 along with the taking of all reasonable precautions to prevent and suppress fires and other detrimental items which may be caused by construction operations. This includes protecting streams, lakes and reservoirs from contamination by siltation or other harmful materials, and the use of conservation practices of the Conservation Services by the Contractor, his employees and subcontractors during the work, which will include but are not limited to the following:

(a) Diligently undertake precautions for the prevention of and for suppressive action in the event of fire resulting from highway construction. This will require the Contractor to -

1. Comply with all State laws, rules and regulations for prevention and suppressive action for forest fires.
2. Prepare and submit to the Department a fire prevention and control plan. The fire prevention and control plan must be on file and in effect before work on the item of Clearing and Grubbing will be permitted.
3. Comply with the fire plan noted in Item 2 above. When a burn permit is required, the permit number shall be provided to the Engineer prior to performing the burning operation.

(b) Unmerchantable material including tops, branches, etc., may be disposed of by piling and burning as directed. Alternate methods of disposal, including any of the following methods or combinations of methods (lop and scatter, chip, broadcast, burn, remove, pile only) must be approved in advance by the Engineer.

(c) Protect and preserve the soil and vegetative cover and scenic and aesthetic values on the right of way and on adjacent lands so far as practical and consistent with the construction, operation and maintenance of the highway. An allowable disturbance of soil and vegetation cover outside the construction limits may be shown on the plans. The Contractor's proposed disturbance of soil and vegetation cover outside of the construction limits will only be allowed upon written approval of the Engineer.

(d) The Contractor shall be responsible for the prevention and control of soil erosion and gullying within the right of way covered by the project and the lands immediately adjacent thereto as a result of the road construction, and shall revegetate with grass, or other herbaceous plants, ground where the soil has been exposed. Slopes in channel changes on all branches and creeks shall be seeded and fertilized above the water line and in no case will the toe of fill slopes be allowed to fall within stream or creek channels unless adequate slope protection is placed in accordance with plan details or as directed by the Engineer. All soil left within the right of way shall be leveled off and/or dressed out and seeded or sprigged in a manner that will permit healing of ground surface and present a pleasant appearance.

(e) Construction operations shall be planned and conducted in such a manner so as to prevent when necessary and otherwise minimize pollution of streams, lakes and reservoirs with sediment or other harmful material used in the construction of the project.

(f) Waste, loose soil or other materials removed from the roadway or channel changes shall not be deposited in live streams. Depositing material into the streams or stream channel where it

would be washed away by high stream flows will not be permitted. Surplus material may be deposited only in disposal areas approved by the Engineer. Disposal areas outside of the project right of way must be operated so as to blend into the surrounding area utilizing an erosion control plan, etc. as prescribed for the use of offsite areas in Article 106.01 with any cost thereof considered incidental to the use of the disposal area. Disposal areas within the project right of way shall be dressed and treated as directed using erosion control items provided in the contract for payment of directed work.

(g) The hauling of materials, including logs, brush, and debris by fording live streams will not be permitted. Temporary bridges or other structures must be provided for this purpose.

(h) Operations of mechanized equipment in live streams or stream channels will not be permitted except in areas where channel changes, retaining walls, temporary or permanent bridges or other such work is required by the plans, or directed.

(i) Fuels, oils, bitumen or other greasy or chemical substances originating from construction operations shall not be allowed to enter or be placed where they may enter a live steam.

(j) The outlet ends of all channel changes shall be so laid out and aligned as to provide direct flow into old stream beds without an abrupt direction change.

(k) The operations for any material pit located within sight of the project right of way or any other State or Federal highway shall be conducted in accordance with the requirements given in Article 106.01, allowing adequate space for conservation of existing natural screenings or permit the installation of screen planting between the road surface and the disturbed area. Pit sites shall be dressed to obliterate any unsightly appearance and treated in such a manner that erosion of the pit will not occur and result in the pollution of the water shed area.

107.14 Responsibility for Damage Claims.

(a) General.

The Contractor shall indemnify and save harmless the State, the Department, the County, the Municipality, the officers and employees from all suits, actions, or claims of any character brought because of any injuries or damages received or sustained by any person, persons, or property due to the operations of the Contractor; or because of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of the Contractor; or because of any claims or amounts arising or recovered under the "Workmen's Compensation Act" or any other law, ordinance, order, or decree; and so much of the money due the Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of the State; or, in case no money is due, his surety will be held liable until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

The State will not be liable to the Contractor for damage or delays resulting from work by third parties or by injunctions or other restraining orders obtained by third parties except as noted in Subarticle 108.07(b).

(b) Temporary Stream Crossings.

When the Contractor is required to construct temporary stream crossings, the responsibility of the Contractor as above set forth shall extend to and include such structures together with their approaches.

(c) Reporting Accidents.

The Contractor shall submit a verbal report to the Engineer no later than the next working day after their occurrence all accidents occurring on the work which involve the public or the Contractor's forces. Accidents involving fatalities shall be verbally reported within eight hours. The Contractor shall follow this verbal report with a written report within ten calendar days after the accident. The report shall contain complete information on the accident including names, addresses of persons involved, and names and addresses of witnesses.

107.15 Liability Insurance.

The Contractor, without extra compensation, shall carry insurance of the following kinds and amounts in addition to any other forms of insurance or bonds required under the terms of the contract specifications. All insurance shall be by companies authorized to do business in Alabama involving these

types of insurance. Before beginning work, the Contractor shall have on file with the Department's Bureau of Office Engineer a valid insurance certificate showing the amounts of insurance carried and the risks covered thereby, or a copy of the policies, covering the requirements outlined herein in this Article, along with Workmen Compensation coverage, before he will be allowed to perform any work on a contract.

It shall be the Contractor's responsibility to provide the information on his coverage in a timely and acceptable manner. The Department will not be responsible for delays or damages caused by failure on his part to provide this information in a timely, acceptable manner.

Certificates of coverage shall be on the Department's Form OE-04, or a form acceptable to the Department, that provides all of the information required by Form OE-04. Certificates shall have an original signature of the local (within the State of Alabama) representative of the insurance company providing coverage.

The insurance coverage shall be provided on a continuous basis from the date work begins until the contract has been completed. Certificates of insurance shall indicate the policy period of the coverage. Should insurance coverage expire before the work is complete or the insurance company cancels the policy (30 day notice required), work on the project for the construction firm involved will be halted until a notice of renewal of the coverage is received by the Bureau of Office Engineer. The Department will not be responsible for any delays, damages, or claims on the part of the contracting firm not providing renewal certificates in a timely and acceptable manner. If work is halted as outlined above, working time will be charged as outlined in Subarticle 108.08(a).

(a) Contractor's Bodily Injury Liability and Property Damage Liability Insurance.

The Contractor without extra compensation shall carry for himself, and shall require from all Subcontractors on the contract, until the contract is completed, with respect to the operations he or the Subcontractors perform, both premises operations and independent contractor's coverages, contractor's bodily injury liability insurance providing for a limit of not less than $100,000 for all damages arising out of bodily injury to or death of one person, and subject to that limit for each person, a total limit of $300,000 for all damages arising out of bodily injury to or death of two or more persons in any one occurrence.

The Contractor without extra compensation shall carry for himself, and shall require from all Subcontractors on the contract, until the contract is completed, with respect to the operations he or the Subcontractors perform, both premises operations and independent contractor's coverages, contractor's property damage liability insurance providing for a limit of not less than $50,000 for all damages arising out of injury to or destruction of property in any one occurrence and a total of $100,000 for all occurrences during the policy period.

(b) Railroad's Protective Bodily Injury Liability and Property Damage Liability Insurance.

When the contract specifies such, the Contractor shall carry insurance for himself and insurance in the name of the railroad company in the amounts and under the terms specified in special provisions provided in each contract; otherwise, the provisions of Subarticle 107.15(a) shall apply.

(c) Automobile and Truck Bodily Injury Liability and Property Damage Liability Insurance.

The Contractor without extra compensation shall carry for himself, and shall require from all Subcontractors and all owners of automobiles or trucks rented or hired on the contract, until the contract is completed, automobile and truck bodily injury liability and property damage liability insurance for not less than the limits prescribed by the Alabama Financial Responsibility Law. The Contractor also shall carry for himself insurance for non-owned and hired automobiles and truck coverage to at least the limits prescribed by the Alabama Financial Responsibility Law.

107.16 Opening Sections of Project to Traffic.

Opening of sections of the work to traffic prior to completion of the entire contract may be desirable from a traffic service standpoint, or may be necessary due to conditions inherent in the work, or by changes in the Contractor's work schedule, and may be necessary due to conditions or events unforeseen at the time of the contract. Such openings as may be necessary due to any of the foregoing conditions shall be made when so ordered by the Engineer. Under no condition shall such openings constitute acceptance of the work or a part thereof, or a waiver of any provisions of the contract.

The plans and/or special provisions shall state, insofar as possible, which sections shall be opened prior to completion of the contract. On any section opened by order of the Engineer, whether covered on the plans or in the special provision or not, the Contractor shall not be required to assume any expense entailed in maintaining the road for traffic. Such expense shall be borne by the Department, or

compensated for in a manner provided in Article 109.04. On such portions of the project which are ordered by the Engineer to be opened for traffic, in the case of unforeseen necessity which is not the fault of the Contractor, compensation for additional expense, if any, to the Contractor and allowance of additional time, if any, for completion of any other items of work on the portions of the project ordered by the Engineer to be opened in the event of such unforeseen necessity, shall be as set forth in a change order mutually agreed on by the Engineer and the Contractor as set forth herein.

If the Contractor is dilatory in completing shoulders, drainage structures, or other features of the work, the Engineer may so notify him in writing and establish therein a reasonable period of time in which the work should be completed. If the Contractor is dilatory or fails to make a reasonable effort toward completion in this period of time, the Engineer may then order all or a portion of the project opened to traffic. On such sections which are so ordered to be opened, the Contractor shall conduct the remainder of his construction operations so as to cause the least obstruction to traffic and shall not receive any added compensation due to the added cost of the work by reason of opening such section to traffic.

On any section opened to traffic under any of the above conditions, whether stated on the plans or in the Special Provisions or opened by necessity of Contractor's operations, or unforeseen necessity, any damage to the highway not attributable to traffic which might occur on such section (except slides) shall be repaired by the Contractor at his expense. Slide corrections performed by the Contractor shall be compensated for in accordance with the provisions of Article 210.10.

107.17 Contractor's Responsibility for Work.

Until final written acceptance of the project by the Engineer, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of governmental authorities.

Where a roadway is open to traffic, damage caused by public traffic to any acceptably installed permanent item(s) of work shall be repaired by the Contractor before final acceptance. Damage to portable impact attenuators shall be repaired by the Contractor as necessary. If the damage to these items was not caused by the fault or negligence of the Contractor, then the Contractor will be compensated for the repair work either at the contract unit bid price(s) of the original item(s) of work or as extra work, as determined by the Engineer.

In case of suspension of work, the Contractor shall be responsible for the project, provide for normal drainage and shall erect any necessary temporary structures, signs, or other facilities at his expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under his contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

107.18 Furnishing Right-Of-Way.

The Department will be responsible for the securing of all necessary rights-of-way in advance of construction. Any exceptions will be indicated in the contract.

107.19 Personal Liability of Public Officials.

In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Director, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.20 No Waiver of Legal Rights.

Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance and processing of the final estimate, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or his surety, or both, such overpayments as it may sustain, or by failure

on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107.21 Stormwater Management.

(a) Protection of Project Site and Adjacent Property.

The Contractor shall perform the work while protecting the project site and adjacent property from contaminated and turbid stormwater runoff. The requirements in Section 665 shall apply to all work regardless of whether or not any of the pay items of Section 665 are included in the contract. When a pay item is not in the contract for an item of temporary erosion control, and the work is deemed necessary by the Engineer to restore or maintain compliance with the ADEM NPDES General Permit or the contract, the work will be paid for as Extra Work. The Contractor shall minimize the introduction of and remove sediment, nutrients, and other pollutants in stormwater runoff originating within the ALDOT right of way. The quality of water originating off of the right of way and entering the project site shall not be diminished as it flows through the site.

(b) Best Management Practices.

The Contractor shall implement and maintain appropriate structural and nonstructural Best Management Practices (BMPs) for the prevention and control of nonpoint sources of pollutants, e.g., sediment, oil and grease, chemicals, etc., during project construction. The Contractor shall abide by the regulations of the Alabama Department of Environmental Management (ADEM) applicable to construction stormwater and the National Pollutant Discharge Elimination System (NPDES) General Permit.

(c) NPDES Permit Coverage for Construction Stormwater Discharge.

A Project Note will be shown on the plans indicating the status of NPDES permit coverage for construction stormwater discharge and the availability of a preliminary ALDOT Construction Best Management Practices Plan (CBMPP) for the project. When NPDES permit coverage is required and retained by ALDOT, the Alabama Department of Transportation is considered to be the Permittee and the Engineer is considered to be the Responsible Official. When NPDES permit coverage is required and retained by the Local Public Agency (LPA), the LPA is considered to be the Permittee and the LPA will designate their Responsible Official. The Permittee is responsible for all required NPDES Permit maintenance, renewal, modification, and termination.

The Contractor shall be responsible for obtaining applicable NPDES permit coverage through ADEM for all material pits, waste areas, plant sites, haul roads and other off-site areas selected by the Contractor to construct the project. Copies of the written acknowledgement from ADEM verifying that permit coverage has been obtained shall be forwarded to the Engineer with or as part of the Contractor’s Stormwater Management Plan (SWMP) before ground is disturbed in these areas.

(d) Weather Preparedness and Recovery.

The Contractor shall prepare a project specific weather preparedness and recovery plan as part of the Contractor’s SWMP. At a minimum, the plan shall include details to implement the following four components to the maximum extent practicable:

1. Unexpected Weather Preparations.
   - Cover unstabilized ditches with polyethylene, or other material, securely anchored to prevent erosion of the channel. Where feasible, the required permanent stabilization should be installed instead of temporary measures.
   - Cover unstabilized slopes with Temporary Mulching, polyethylene, or other material, securely anchored to prevent erosion of the slope. Where feasible, the required permanent stabilization should be installed instead of temporary measures.
2. Forecasted Weather Preparations.
   - Plan work to minimize additional soil disturbance in the days preceding an event.
   - Ensure all BMPs are properly installed and maintained to prevent erosion, capture sediment, and reduce turbidity.

- Cover unstabilized ditches with polyethylene, or other material, securely anchored to prevent erosion of the channel. Where feasible, the required permanent stabilization should be installed instead of temporary measures.
- Cover unstabilized slopes with Temporary Mulching, polyethylene, or other material, securely anchored to prevent erosion of the slope. Where feasible, the required permanent stabilization should be installed instead of temporary measures.

3. Severe Weather Preparations.
   - Dewater basins and close basin outlet pipe valves to maximize the capture and treatment of turbid stormwater.
   - Install temporary diversions to route stormwater away from critical areas.
   - Remove sediment from existing BMPs to maximize the capture of new sediment.
   - Review and improve or upgrade BMPs which have performed poorly during previous precipitation events.
   - Plan work to minimize additional soil disturbance in the days preceding an event.
   - Ensure all BMPs are properly installed and maintained to prevent erosion, capture sediment, and reduce turbidity.
   - Cover unstabilized ditches with polyethylene, or other material, securely anchored to prevent erosion of the channel. Where feasible, the required permanent stabilization should be installed instead of temporary measures.
   - Cover unstabilized slopes with Temporary Mulching, polyethylene, or other material, securely anchored to prevent erosion of the slope. Where feasible, the required permanent stabilization should be installed instead of temporary measures.

4. Weather Recovery.
   - Immediately repair any breach in basin dams.
   - Remedy hazardous conditions.
   - Conduct a Site Inspection of the entire project site in accordance with Item 107.21(e)2.
   - Create a schedule of needed Corrective Actions in accordance with Item 107.21(e)4., which will be included in the Noncompliance Notification Report submitted to ADEM; set repair priorities starting at the discharge point in each drainage area when possible and evaluate environmental impacts, offsite impacts, timeliness of accessibility for repairs, and public perception.

(e) Inspections and Corrective Actions

1. Daily Observations.

The Contractor's Qualified Credentialed Inspector (QCI) and the Department's Project QCI shall perform daily observations of discharge points and areas of the project where the ground is disturbed and record rainfall measurements and weather information. If any previously undocumented BMP deficiencies or other regulatory violations are observed, the Project QCI will notify the Department's Project Qualified Credentialed Professional (QCP), the Contractor QCI shall notify the Contractor QCP and/or Superintendent, and a formal Site Inspection will be performed.

2. Site Inspections.

When the project is covered by the NPDES General Permit, formal inspections shall be made by the Contractor QCI and the Project QCI together, under the supervision of the Contractor QCP and/or Superintendent and the Project QCP, respectively. Project site inspections of the construction best management practices shall be made by the QCIs per the requirements of the NPDES permit and no less frequently than once per week and after the accumulation of 3/4 inch {75 mm} of rainfall within 24 hours. The project site inspections shall be initiated as soon as possible and within 24 hours of resuming work on the project and shall be completed no later than 5 days after a qualifying rain event. Inspection Certification Reports and Noncompliance Notification Reports (if warranted) will be entered into the Department's Stormwater Tracking System (SWTS) by the Project QCI. Required verbal notifications of noncompliance to ADEM are the responsibility of the Permittee.

Construction stormwater sampling and turbidity monitoring shall be performed by the Permittee when directed by the Project QCP or as required by the NPDES General Permit. The Contractor QCI and the Project QCI shall both be present during stormwater sampling. Stormwater Turbidity Sampling Reports (if required) will be entered into the Department's SWTS by the Project QCI.

If the NPDES permit is held by the LPA, the reports shall be written using ADEM's Form 23 11/11 or Form 25 11/11 (if applicable) by the LPA QCI. Formal inspections shall be reported to ADEM by the

Permittee in accordance with NPDES permit requirements. Copies of all draft reports shall be provided to the Engineer no later than 24 hours after the inspection. Copies of signed reports shall be submitted to the Engineer no later than 5 days after the inspection.

3. QCP Site Evaluations.

The Permittee's Qualified Credentialed Professional (QCP) shall personally perform site evaluations in accordance with the NPDES General Permit at least once per every three months for Priority Construction Sites and once per every six months for Non-priority Construction Sites. These evaluations shall consist of an onsite inspection of all erosion, sediment, and turbidity control best management practices being implemented to determine adequacy and consistency with site conditions and shall include a review of the CBMPP to ensure proper maintenance. The resulting inspection reports shall be submitted to ADEM by the Permittee's QCP. For ALDOT held NPDES permits, the resulting inspection reports will be entered into the Department's SWTS by the Project QCP.

4. Corrective Actions.

If an inspection report reveals anything outside of regulatory compliance, the NPDES General Permit requires immediate corrective action shall be taken by the Contractor and completed prior to the next storm event but no later than 5 days after the inspection unless prevented by unsafe weather conditions. Additional inspections shall be performed until the observed deficiency is corrected and in compliance with the NPDES General Permit. Should discharges from construction activity cause or contribute to instream turbidity exceeding background turbidity by more than 50 nephelometric turbidity units (NTUs), or cause substantial visible contrast with background turbidity, the Contractor shall suspend construction activity in the drainage area discharging to the affected Stormwater Discharge Point until effective corrective actions are implemented and instream turbidity decreased to acceptable levels. The suspension of construction activities includes all operations that are not directed toward correction of erosion, sediment, and turbidity control best management practices, permanent stabilization, or returning the project to regulatory compliance. ALDOT has the right to require the suspension of similar construction activities throughout the project should conditions and actions by the Contractor be deemed unacceptable by the Engineer.

Any damage to properties adjacent to the project site due to the Contractor's acts, omissions, misconduct, intentional or negligent conduct regarding stormwater management shall be restored in accordance with the requirements of Article 107.12. Any regulatory fines, costs, damages, or expenses incurred by ALDOT due to the Contractor's acts, omissions, misconduct, intentional or negligent conduct shall be reimbursed to ALDOT or otherwise compensated by the Contractor. Any regulatory fines, costs, damages, or expenses incurred by the Contractor for off-site areas are and shall be the sole and exclusive responsibility of the Contractor.

(f) NPDES Permit Termination.

The Contractor shall be responsible for stormwater runoff control on the project until the NPDES General Permit for coverage of construction stormwater is terminated. Termination of NPDES Permit coverage can only be requested after Acceptance for Maintenance and approval by the Engineer. Termination shall be requested no later than 10 days after Acceptance for Maintenance.

107.22 Environmental Protection and Spill Prevention.

The Contractor shall comply with all Federal, State and local laws and regulations controlling pollution of the environment. The Contractor shall also take all reasonable precautions to prevent pollution of streams, lakes, ponds, reservoirs and other waters of the State with fuels, oils, bitumens, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

The Contractor shall comply with all ADEM and local air pollution control programs within the State, and their rules and regulations regarding air pollution matters, especially "open burning", "fugitive dust", and "asphalt batching plant" restrictions. A valid permit for "open burning" or operation of an "asphalt batching plant" will be required from the air pollution control agency within whose jurisdiction the work is to be performed before such operations will be allowed.

Construction and worker debris shall not be exposed to precipitation or stormwater. All construction and worker debris (trash, garbage, discarded construction materials, etc.) shall be immediately removed and disposed of in an approved manner.

The Contractor shall minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, concrete washout, and other wash waters. Prior to discharge, all wash waters and dewatering discharges shall be captured and treated. Concrete and other material washout pits shall be

lined with geotextile filter fabric and have a perimeter barrier to prevent material transport by stormwater.

When the Contractor's operations encounter or expose any abnormal, or potentially abnormal, condition which may indicate the presence of a hazardous and/or toxic waste, such operations shall be discontinued in the vicinity of the abnormal condition and the Engineer shall be notified immediately. The presence of barrels, discolored earth, metal, wood, visible fumes, abnormal odors, excessively hot earth, smoke or anything else which appears abnormal may be indicators of hazardous and/or toxic wastes and shall be treated with extraordinary caution.

The Contractor shall not resume operations in the vicinity of the abnormal condition until so directed by the Engineer. Disposition of the hazardous and/or toxic waste shall be made in accordance with the requirements and regulations of the Alabama Department of Environmental Management, these specifications, and as directed by the Engineer.

Where the Contractor performs work necessary to dispose of hazardous and/or toxic waste, payment will be made at the unit prices for pay items included in the contract which are applicable to such work. When the contract does not include such pay items, payment will be made as provided in Article 109.04 for extra work.

The Contractor shall submit to the Engineer and implement a Spill Prevention Control and Counter Measures (SPCC) Plan for all fuel or chemical storage tanks or facilities located on ALDOT right of way. The SPCC shall be submitted in accordance with the regulations given in the ADEM Administrative Code and the NPDES General Permit. The Contractor shall maintain on-site, or have readily available, sufficient oil and grease absorbing material and flotation booms to contain and clean up fuel or chemical spills and leaks. Soil contaminated by paint or chemical spills, oil spills, etc., shall be immediately cleaned up or be removed and disposed of in an approved manner.

107.23 Temporary Construction Encroachment into Streams, Water Bodies and Wetlands.

Temporary encroachment into streams, water bodies and wetlands may be shown as a part of the contract requirements if the encroachment is necessary for the completion of the work. A Contractor shall submit a request for all other temporary encroachments into streams, water bodies and wetlands if the encroachment is not prohibited by requirements given in the contract. Requests shall be submitted for proposed temporary stream crossings, temporary water diversions, and temporary work bridges and platforms.

A request for a temporary encroachment shall be submitted as an attachment to the Contractor’s Stormwater Management Plan and forwarded to the State Construction Engineer for review and acceptance. The submittal of the request shall contain the following:

1. A description of how water quality will be protected during the encroachment.
2. A drawing of the proposed encroachment including a dimensioned plan view and elevation view depicting the location and distances from the water body, existing ground elevation, and proposed and existing structures.
3. The drawing shall also include details and dimensions of the pipes, bridges, or other facilities allowing the passage of water. It shall be the responsibility of the Contractor to ensure the opening under or through the drainage facilities is adequately sized to allow for normal seasonal flows.
4. A description of the sequence of placement and eventual removal of any temporary fill.
5. The type and estimated volume in cubic yards {cubic meters} and tons {metric tons} of any fill material proposed to be placed.
6. Provisions required to prevent fill from being eroded and measures for recovering and removing any fill material that is eroded.

US Army Corps of Engineers or other regulatory approval and notice may be required for the encroachment into streams, water bodies and wetlands. Corps of Engineers approval that is not given to the ALDOT or to the County holding the Nationwide Permit for the project will not be accepted as being adequate regulatory authorization for the encroachment.

All encroachments into streams, water bodies and wetlands shall be done in accordance with the requirements of regulatory permitting, approvals and conditions. Encroachments shall be done in a manner that will minimize the adverse affect on the quality of the water. Maintenance shall be performed

as necessary to ensure water passage and to ensure that neither fill nor water is contaminated by equipment fluids or by loose materials falling from equipment.

The methods and materials proposed for temporary encroachments into streams, water bodies and wetlands and the protection of water quality during an encroachment shall be done by the Contractor with no direct payment unless shown otherwise on the plans.

107.24 Permits for Pesticide Application.

All pesticide (including herbicide) applications shall be done under the on-site, direct supervision of a person possessing a Commercial Pesticide Application Permit and a Professional Services Permit (turf and ornamentals category) or a Commercial Applicator Permit and a Custom Applicator Permit (right-of-way pest control category) issued through the Alabama Department of Agriculture and Industries. Proof of the possession of these permits shall be furnished to the Engineer prior to the commencement of work. Any work performed without the on-site, direct supervision of these permitted individuals will be subject to rejection by the Engineer.

SECTION 108
PROSECUTION AND PROGRESS

108.01 Subletting and Assignment.

(a) Subletting.

1. Limitations of the Extent of Subletting.

The Contractor shall not sublet the contract or any portion thereof, or of his right, title, or interest therein, without written consent of the Engineer. If such consent is given, the Contractor will be permitted to sublet a portion of the work, but shall perform with his own organization, work amounting to not less than 30 percent of the total contract cost. A Contractor that does not perform at least 30 percent of the work with his own organization may be disqualified from further bidding and may not be approved for work in any role or capacity on an ALDOT project.

Upon default of the Contractor, the surety will be permitted to have all of the work performed under sublet approval.

Work performed without sublet approval will be designated as unauthorized work as noted in Article 105.11.

Any items designated in the contract as "specialty items" may be performed by subcontract and the cost of such specialty items performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the contractor with his own organization. No subcontracts, or transfer of contract, shall relieve the Contractor of his liability under the contract and bonds.

The Department reserves the right to disapprove a request for permission to sublet when the proposed Subcontractor has been disqualified from bidding for those reasons listed in Subarticle 102.02(b).

2. Subcontractor's Status.

A Subcontractor shall be recognized only in the capacity of an employee or agent of the Contractor and his removal may be required by the Engineer, as in the case of an employee.

(b) Assignment.

The performance of the contract may not be assigned, except upon the written consent of the Director. Consent will not be given to any proposed assignment which would relieve the original Contractor or his surety of their responsibilities under the contract nor will the Director consent to any assignment of a part of the work under the contract.

The Contractor may assign moneys due or to become due him under the contract, if such assignment is approved by the Director, to the extent permitted by law, but any assignment of moneys shall be subject to all proper set-offs in favor of the Department and to allow deductions provided for in the contract and particularly all money withheld, whether assigned or not, shall be subject to being used by the Department for the completion of the work in the event that the Contractor should be in default therein.

An assignment by operations of law or assignment for the benefit of creditors, or the bankruptcy of the Contractor, shall not vest any right in this contract in the Trustee in bankruptcy, the Contractor's creditors, or the agent of the creditors.

In no case will the Department make the warrant payable to anyone other than a party to the contract and; therefore, if the contractor assigns the proceeds of his contract to a bank or other individual or company, approval of the assignment by the Director only constitutes an agreement to make the warrants payable to the contractor and for it to be mailed to the address of the party to which the contract is assigned.

108.02 Notice to Proceed.

(a) General.

A notice to proceed shall be issued by the Engineer within 15 calendar days after final execution of the contract by the Director and approval by the Governor, unless both parties agree in writing to a stipulated extension in time for the issuance of a notice to proceed. Unless the Contractor is otherwise notified in writing, it shall be understood that the mailing or the delivery to the Contractor or his authorized agent, of a copy of the executed and approved contract and bonds or the mailing of written notice by the Engineer or receipt of telegraphic notice from the Engineer, that the contract has been approved by the Governor, shall constitute the notice to proceed. If the Contractor is notified in writing that none of the above shall constitute notice to proceed, he shall not commence work until receipt of a written notice to proceed signed by the Engineer.

(b) Time of Beginning Work.

Unless otherwise directed in writing by the Engineer, the Contractor will be expected to begin work within 15 calendar days after issuance of notice to proceed.

108.03 Progress Schedule of Operations.

(a) Bar Graph Schedule

On all projects which have a contract time in excess of 90 working days or 180 calendar days, the Contractor shall submit a satisfactory, comprehensive bar graph schedule of operations to the Area Construction Engineer prior to the Preconstruction Conference. This schedule shall be on Form C-10 furnished by the Department at the time of contract award. Said schedule of operation shall provide a bar for each major phase of construction such as, but not limited to, clearing and grubbing, grading, drainage structures, bridges, base, shoulders, paving, etc. with an estimated start and completion date for each bar and an overall project completion date, all within the specified contract time. In lieu of the Form C-10, the Contractor will be allowed to submit their Critical Path Method schedule of operations as a pdf file if the above information is included. The Engineer may order the submittal of a bar graph schedule of operation on any project which has a contract time less than that specified above should he deem such necessary for project control.

A revised bar graph schedule and completion update may be required within ten days of the occurrence of any one of the following conditions: (1) at each major change from the original submitted, (2) when a time extension is granted, and (3) when a revised bar graph schedule is requested by the Engineer.

The Engineer's approval of the aforementioned Schedule of Operations does not waive any contract requirements.

(b) Critical Path Method Schedule

On all projects which have a contract time in excess of 180 working days or 360 calendar days, the Contractor shall submit to the Engineer for acceptance a Critical Path Method (CPM) Schedule for the project within 7 calendar days after full execution of the Contract or at the preconstruction conference, whichever is earlier. This CPM Schedule will be used in lieu of the bar graph schedule of operation in evaluating work progress.

The CPM Schedule shall include detailed schedule diagrams and schedule data as described below for the entire Contract Time (this term is defined in Article 101.01). The CPM Schedule shall be consistent with the Sequence of Construction, or approved revisions, showing discrete activities for each operation to be accomplished within each phase, and shall include activities for submittals, deliverables, and reviews in the schedule. Sufficient liaison shall be conducted and information provided to indicate coordination with utility owners having facilities within the project limits. The schedule must reflect the utility adjustment schedules as shown in the contract, unless changed by mutual agreement of the utility company, the Contractor, and the Department.

Failure to include any element of work or any activity relating to utility work will not relieve the Contractor from completing all work within the contract time at no additional time or cost to the Department, notwithstanding the acceptance of the schedule by the Department.

The CPM Schedule may indicate a completion date in advance of the expiration of contract time. However, the Department will not be liable in any way for the Contractor's failure to complete the project prior to expiration of contract time. Any additional costs, including extended overhead incurred between the Contractor's scheduled completion date and the expiration of contract time, shall be the responsibility of the Contractor. The Contractor shall not be entitled to claim or recover any such costs from the Department.

Acceptance of the CPM Schedule by the Department shall in no way constitute approval or acceptance of any items that are contrary to the plans or other contract documents.

The Engineer may withhold monthly payments due for failure of the Contractor to submit an acceptable schedule or monthly updates within the time frame described herein.

1. Schedule Submissions.

   Each schedule submission and monthly update shall include a minimum of the following items:

   a. A Critical Path Method (CPM) Schedule in Gantt Chart view, by week starting on Monday, grouped (banded) by phase and sorted by early start days. Prominently identify the critical path activities, defined as the longest continuous path of work activities. Submit the Gantt Chart, printed in color on 11 inches x 17 inches paper and as a PDF file. The schedule shall contain, as a minimum, the following information for each schedule activity: identification, detailed activity description, total duration, remaining duration, start date, late finish date, and total float.

   b. A report with the following schedule activity information for each construction activity: identification, description, original duration, remaining duration, start date, finish date, total float and percent complete. The Gantt Chart diagram shall not be included in this report. It will be submitted on 11 inches by 17 inches paper.

   c. A schedule narrative report describing current project schedule status and identifying potential delays. This report will include a description of the progress made since the previous schedule submission and objectives for the upcoming 30 calendar days. It will be submitted on 8.5 inches by 11 inches paper. This report shall at a minimum include the following information:

      1. This report shall indicate if the project is on schedule, ahead of schedule or behind schedule. If the project is ahead of schedule or behind schedule, the report shall include the specific number of calendar days. If the project is behind schedule, the report shall include a detailed recovery plan that will put the project back on schedule.
      2. The report will describe the current critical path of the project and indicate if this has changed in the last 30 calendar days. Discuss current successes or problems that have affected either the critical path's length or have caused a shift in the critical path within the last 30 calendar days. Identify specific activities, progress, or events that may reasonably be anticipated to impact the critical path within the next 30 calendar days, either to affect its length or to shift it to an alternate path.
      3. List all schedule logic or original duration changes that have been made to the schedule since the previous submission. For each change, describe the basis for the change and specifically identify the affected activities by identification number.
      4. Identify any and all activities, either in progress or scheduled to occur within the following 30 days that require Department participation, review, approval, etc.
      5. A milestone report summarizing all project milestones and their current status.

The Engineer will have 14 calendar days to review and accept the CPM Schedule or to schedule a meeting with the Contractor to resolve any problems that prevent acceptance of the schedule. The Contractor shall attend the meeting with the Engineer and submit a corrected Schedule to the Engineer within seven calendar days after the meeting. The process will be continued until a CPM Schedule is accepted by the Engineer.

Upon the Engineer's acceptance of the CPM Schedule, the Contractor shall submit monthly updated files and reports reflecting progress within three calendar days after the monthly estimate cut-off date. The Data Date of each updated schedules shall correspond with the monthly estimate cutoff date.

2. Schedule Content.

All schedule submissions shall comply with the following content guidelines as appropriate to the specific submission:

Outline Schedule Diagrams and Data shall show the sequence, order, and interdependence of major construction milestones and activities. Include ordering and procurement of critical materials and equipment, long-lead time items, and key milestones identified by the Contract. Identify planned work schedule(s) and include all non-workdays.

Provide a description of each major construction activity and key start and finish milestones.

Detailed Schedule Diagrams shall include activity number, description, start and finish dates, float, and all relationships (i.e. logic ties). Show the sequence, order, and interdependence of activities in which the work is to be accomplished. Include allowance for Department oversight, acceptance and return of submittals, samples, shop drawings and working drawings where Department acceptance is specifically required (in accordance with Article 105.02 of the standard specifications). In addition to construction activities, detailed network activities shall include the submittals, procurement, and Department or Utility activities impacting progress:

a. Submittal activities shall include oversight and acceptance of submittals. If the Department's action on any submittal is “Not Accepted” or “Revise and Resubmit”, a new series of submittal preparation activities shall be inserted into the schedule. Predecessor for the new submittal preparation activity will be the original acceptance activity and the successor of the new acceptance activity will be the fabrication/delivery activity for the equipment or material.

b. Procurement activities shall include all critical materials and equipment, fabrication of special material and equipment, and their installation and testing.

c. Show activities of the Department or Utilities that affect progress and contract-required dates for completion of all or parts of the work.

Detailed Schedule Data shall conform to the following:

a. All activities shall be assigned to a specific calendar within the software. Specific calendars will be defined within the software to include planned work days. These calendars will include both Contractor and Contract defined holidays and suspension days as non-workdays.

b. At a minimum, major milestones shall include the following:

1. Start of construction.
2. Finish of construction.
3. Roadway or ramp closures.
4. Roadway or ramp openings.
5. Traffic shifts
6. Critical material deliveries
7. Bridge Foundations (per Bridge)
8. Bridge Substructure (per Bridge)
9. Bridge Superstructure (per Bridge)
10. Completion of activities for incentive payment (if applicable)

c. All non-procurement activities must be less than or equal to 20 workdays and include no more than one contractor or sub-contractor unless approved by the Engineer to be greater.

d. Only two open-ended activities (the first and the last) are allowed.

e. Constraints shall only be used for “Project Start,” and “Project Completion.” Constraints cannot override logic. The use of any other imposed constraints is not allowed without specific approval by the Engineer. Any other desired constraints must be submitted to the Engineer with the rationale for the use of each desired additional constraint. If allowed by the Engineer, the rationale should be recorded in the activity's notebook field. Mandatory constraints (start and finish) violate network logic and shall not be used.

f. Out of sequence progress, if applicable, shall be handled through Retained Logic. Use of the Progress Override option is not appropriate for this project and will not be allowed.

g. Progress shall be calculated based on percent complete.

h. All changes to activities shall be noted in the schedule narrative. The notebook shall include, as a minimum, the date and reason for the change, as well as reference to a document wherein the Engineer acknowledges and accepts the change.

i. The use of automatic resource leveling is prohibited.

3. Monthly Meetings.

The Contractor shall attend monthly meetings scheduled by the Engineer to discuss Contract progress, near term scheduled activities, including utility relocations, upcoming traffic shifts or changes, Roadway Closures, Lane Closures, anticipated problems, and proposed solutions. The Contractor shall submit a six-week "Look Ahead" planning schedule at each monthly meeting, showing the items of work completed the previous two weeks and the activities planned for the next six weeks. Representatives from each subcontractor shown as being active in the Look Ahead schedule shall also attend the meeting. The schedule will be developed in Gantt Chart format, identifying current and planned activities and related CPM Schedule work activities, including subcontractor work and submittals. Designate all activities that are critical path activities as determined by the currently accepted CPM Schedule. A report shall be submitted at each monthly meeting identifying schedule activity progress including actual start or finish dates achieved for any activities. A filter of all milestones in the schedule shall be provided at each monthly meeting as a separate report. A print out of the full project schedule shall be provided upon the request by the Engineer.

4. Float.

Float is defined as the amount of time the finish of an activity can be delayed. Two kinds of float are possible: Total float is how much an activity can be delayed without affecting the finish date of the project or an intermediate deadline (constraint); it is the difference between the late finish date and the early finish date. Free float is how much an activity can be delayed without affecting its earliest successor. Float is not for the exclusive use or benefit of either the Department or the Contractor.

The use of float suppression techniques, such as preferential sequencing (arranging critical path through activities more susceptible to Department caused delay), special lead/lag logic restraints, zero total or free float constraints, extended activity times, imposing constraint dates other than as required by the contract, or the use of illogical relationships to consume non-critical path float shall be cause for rejection of the CPM Schedule or its updates. The use of automatic Resource Leveling (or similar software features) used for the purpose of artificially adjusting activity durations to consume float and influence the critical path is expressly prohibited.

Negative float shall not be a basis for requesting time extensions. Scheduled completion date(s) that extend beyond the contract completion date (evidenced by negative float) may be used by the Department in computations for assessment of payment withholdings. The use of this computation is not to be construed as a means of acceleration.

5. Time Extensions.

The Contractor may request a time extension in accordance with Article 108.09. An extension of time for performance shall be considered only to the extent that a delay to an activity or activities exceeds the total float along the project critical paths within the current approved schedule.

As a minimum, time extension requests shall contain:

a. A descriptive summary of the changes
b. An analysis of project impact
c. A fragnet that shows the impacted activities before the change
d. A fragnet that shows the impacted activities after the change

Time extensions that do not include the documentation listed above will not be reviewed or considered for approval. If a time extension is approved by the Engineer, the specific activities and the overall CPM Schedule must be updated.

6. Performance of Work.

By submitting a CPM Schedule, the Contractor is making a positive assertion that the project will be constructed in the order indicated on the Schedule, and the Contractor shall pursue the work in accordance with the latest accepted CPM Schedule. Any costs associated with meeting milestones and completing the project within the authorized contract time will be borne solely by the Contractor.

7. As-Built Schedule.

The Contractor must include 'Actual' completion dates for activities completed in each monthly update.

8. Measurement and Payment.

Use of Critical Path Method, software, submittals, and incidentals will not be measured separately for payment, but will be a subsidiary obligation of Mobilization. Scheduled mobilization payments maybe reduced or withheld until the initial CPM Schedule or monthly updates are reviewed

and accepted by the Engineer. The amount of reduction or amount to be withheld will be equal to 1% of the total lump sum value for Mobilization.

108.04 Prosecution of Work.

(a) Preconstruction Conference.

The Contractor and Subcontractors shall attend a preconstruction conference scheduled by the Engineer and shall describe how the work will be prosecuted.

The preconstruction conference will be held after the award of the contract and prior to the commencement of any work.

(b) Soil Erosion and Stormwater Management.

1. Compliance and Progress.

If the Contractor fails to comply with the requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit, the Erosion and Sediment Control Plan (ESCP), the Construction Best Management Practices Plan (CBMPP), the accepted Stormwater Management Plan (SWMP), other contract documents, or the directions of the Engineer, the Engineer may order the Contractor to discontinue all operations except work in managing erosion, sediment transport, turbidity, and construction stormwater discharge until the requirements are met. Temporary cessation of operations for environmental compliance does not and shall not constitute a delay or qualify for consideration of an extension of contract time. Failure of ALDOT to observe the work of the Contractor does not relieve the Contractor of its contractual responsibility for the prevention of soil erosion and the control of sediment. The Permittee's QCP is responsible for mitigation of damage to public or private property.

The Contractor shall not commence any activities within a drainage area that disturb the soil or expose it to erosive forces until fully prepared to continuously pursue work until permanent soil stabilization is achieved. The installation of temporary soil erosion and sediment control Best Management Practices (BMPs) shall be performed in coordination with the installation of the permanent erosion control features to assure effective continuous erosion control throughout the life of the project. The Contractor will be required to construct, install and maintain all permanent erosion control features as grading advances.

2. Manufacturer Recommendations for Manufactured Products and Devices.

The Contractor shall furnish the manufacturer's recommendations for material selection, installation and maintenance of any manufactured BMP or manufactured component of a BMP to the Engineer prior to installation.

3. Contractor's Stormwater Management Plan.

The Contractor shall prepare a Stormwater Management Plan (SWMP) for all projects. The SWMP is required regardless of the type of work, funding or regulatory permitting. The SWMP is required regardless of whether or not an "Erosion and Sediment Control Plan" is shown in the plans. The most recent version of ALDOT's electronic SWMP template shall be used to create the Contractor's SWMP. The Contractor and the erosion and sediment control Subcontractor, if applicable, shall sign and certify the SWMP. Submitted SWMPs will not be considered complete if the provided template has been modified. Three copies of the SWMP shall be submitted to the Area Construction Engineer at least 7 days prior to the preconstruction conference.

The SWMP shall provide sequences and details of all erosion and sediment control work, clearing and grubbing operations, grading operations and operations establishing permanent erosion control features. The SWMP shall include operational details and identification of personnel and equipment that will be dedicated to implementing the plan at all phases of the work. The SWMP shall include a project specific weather preparedness and recovery plan based on the requirements of Subarticle 107.21(d). Work shall not begin until the SWMP has been accepted as complete by the Engineer.

Written acknowledgement of NPDES permit coverage from ADEM and other required clearances and acknowledgements required by Subarticle 106.01(b) for any offsite waste areas or pits shall be submitted with or included in the SWMP. The details for proposed temporary encroachments into streams, water bodies and wetlands required by Article 107.23 shall be submitted with or included in the SWMP. Requests to store fuel tanks or other chemicals on ALDOT right of way and applicable spill prevention plans required by Article 107.22 shall also be submitted with or included in the SWMP.

4. Fuel Tanks.

Any requests to store a fuel tank on the project right of way shall be accompanied by a Spill Prevention Control and Countermeasures (SPCC) Plan and both shall be submitted with or included in

the SWMP as required in Article 107.22. The use of onsite fuel storage tanks will not be allowed if this is shown to be prohibited on the plans.

5. Erosion and Sediment Control Plan.

When an "Erosion and Sediment Control Plan" (ESCP) is included in the plans, it is considered to be a part of the ALDOT CBMPP. The Contractor shall comply with the requirements of the design details as shown therein. The Contractor may submit requested modifications to the ESCP as part of the SWMP for acceptance or rejection by the Engineer. The ESCP may also be modified by the Engineer as field conditions warrant. The Contractor shall install BMPs in an effective manner and at all locations directed or permitted by the Engineer, regardless of the BMP quantities and locations depicted on the ESCP. All modifications made to the ESCP will be documented in the CBMPP by the Permittee's QCI and certified by the Permittee's QCP.

6. Qualified Credentialed Professionals.

The Department may assign a full-time Qualified Credentialed Professional (Project QCP) to the project. Otherwise another ALDOT QCP, typically the Area Stormwater Coordinator, will perform most of the Project QCP duties. The Project QCP will report to the Project Manager and will be guided by the Area Stormwater Coordinator. The Project QCP will oversee Contractor compliance with the NPDES General Permit, any applicable U.S. Army Corps of Engineers Permit and/or U.S. Fish and Wildlife Service Clearances, the CBMPP, the Erosion and Sediment Control Plan, and the Contractor's SWMP. To accomplish this, the Project QCP duties include:

- Reviewing and approving the Contractor's SWMP;
- Signing as the Operational QCP of the ALDOT CBMPP and maintaining and updating the ALDOT CBMPP Operational Component;
- Possessing knowledge of the location and condition of all discharge points within the project limits;
- Communicating to the Project Manager and the Area Stormwater Coordinator any issues of regulatory noncompliance or any potential violations in the area of environmental protection and construction stormwater;
- Supervising and directing the Project QCIs;
- Providing oversight of the Erosion and Sediment Control Crew (if applicable) and the installation, maintenance, repair, correction and removal of BMPs;
- Providing oversight of the Contractor's forces during clearing, grading, and construction of stormwater conveyances in order to minimize the potential for negative environmental impact;
- Communicating with the Project Manager and Contractor QCP (or superintendent) a minimum of once per month and attending project meetings;
- Reviewing and approving Inspection Certification Reports and coordinating with ALDOT and Contractor personnel to ensure that any stormwater related issues are addressed in a timely manner;
- Conducting quarterly formal Stormwater Site Evaluations for Priority Construction Sites and semi-annual formal Stormwater Site Evaluations for Non-priority Construction Sites as described in Item 107.21(e)3 and entering the corresponding Inspection Certification Reports into the Stormwater Tracking System;
- Accompanying personnel from ADEM and other regulatory agencies on all regulatory inspections of the project and communicating the proceedings and outcomes to the Project Manager and the Area Stormwater Coordinator;
- Representing the Department before regulatory agencies as its Qualified Credentialed Professional and directing any mitigation efforts on behalf of the Department.

7. Qualified Credentialed Inspectors.

a. Contractor's Qualified Credentialed Inspectors

The Contractor shall assign to each project a full-time primary and a backup Qualified Credentialed Inspector (Contractor QCI) certified by ADEM and verified by ALDOT. The Contractor QCI shall be an employee of the Contractor. The name, contact information, and credentials of the Contractor QCIs shall be included in the SWMP and the Engineer shall be notified whenever a substitute Contractor QCI is assigned by the Contractor. There will be no direct compensation for the Contractor QCIs.

The Contractor QCI shall work under the direct supervision of the Contractor QCP and/or superintendent. The Contractor QCI shall be in charge and direction of the Contractor's work regarding the implementation of the CBMPP, the ESCP, and the SWMP, and shall have the authority from the Contractor to mobilize crews to make immediate repairs to BMPs during working and non-working hours. To accomplish this, the Contractor QCI duties include:

- Possessing knowledge of the Contractor's SWMP, the ESCP, the CBMPP, the NPDES General Permit requirements, and if applicable the requirements of the U.S. Army Corps of Engineers Permits and/or U.S. Fish and Wildlife Service Clearances;
- Maintaining QCI certification by attending required refresher training;
- Possessing knowledge of the location and condition of all discharge points within the project limits;
- Communicating to the Contractor QCP and/or superintendent any issues of regulatory noncompliance or any potential violations in the area of environmental protection and construction stormwater;
- Guiding the Erosion and Sediment Control Crew (if applicable) and the Contractor's forces as directed by or in the absence of the Contractor QCP and/or superintendent, during the installation, maintenance, repair, correction and removal of all BMPs in order to minimize the potential for negative environmental impact;
- Reporting to the Contractor QCP and/or superintendent a minimum of once per week and attending project meetings in the absence of the Contractor QCP and/or superintendent;
- Inspecting BMPs on a daily basis to ensure that all controls are in place at all times and ensuring conformance with the contract documents;
- Conducting all required formal stormwater inspections, turbidity monitoring and construction stormwater sampling described in Item 107.21(e)2. with ALDOT personnel;
- Coordinating with Contractor and ALDOT personnel to ensure that any stormwater related issues are addressed in a timely manner.

b. Department's Qualified Credentialed Inspectors

The Department will assign to each project at least one full-time Qualified Credentialed Inspector (Project QCI), certified by ADEM. The Project QCI will work under the direct supervision of the Project QCP and/or Project Manager. The Project QCI will assist the Project QCP and/or Project Manager with overseeing Contractor adherence to the requirements of the NPDES General Permit, the CBMPP, the Erosion and Sediment Control Plan, and the Contractor's SWMP. To accomplish this, the Project QCI duties include:

- Possessing knowledge of the Contractor's SWMP, the ESCP, the CBMPP, the NPDES General Permit requirements, and if applicable the requirements of the U.S. Army Corps of Engineers Permits and/or U.S. Fish and Wildlife Service Clearances;
- Maintaining QCI certification by attending required refresher training;
- Possessing knowledge of the location and condition of all discharge points within the project limits;
- Communicating to the Project QCP and/or Project Manager any issues of regulatory noncompliance or any potential violations in the area of environmental protection and construction stormwater;
- Assisting the Project QCP and/or Project Manager with oversight of the Contractor's forces during clearing, grading, and construction of stormwater conveyances in order to minimize the potential for negative environmental impact;
- Reporting to the Project QCP and/or Project Manager a minimum of once per week and attending project meetings in the absence of the Project QCP and/or Project Manager;
- Inspecting BMPs on a daily basis to ensure that all controls are in place at all times and ensuring conformance with the contract documents;
- Conducting all required formal stormwater inspections, turbidity monitoring and construction stormwater sampling described in Item 107.21(e)2. with the Contractor QCI and entering the corresponding Inspection Certification Reports into the Stormwater Tracking System;
- Coordinating with the Project QCP and/or the Project Manager and Contractor personnel to ensure that any stormwater related issues are addressed in a timely manner.

8. Erosion and Sediment Control Crew.

When required by the plans, the Contractor shall provide a full-time, dedicated Erosion and Sediment Control Crew. The crew shall be under the supervision of the Contractor QCP or superintendent, who shall be assisted by the Contractor QCIs. There will be no direct compensation for the Erosion and Sediment Control Crew.

For all projects, the Contractor shall provide sufficient personnel and appropriate and sufficient equipment and materials on the project at all times to meet the daily erosion and sediment control plan implementation requirements. Additional personnel, equipment, and materials shall be readily available to assist with implementation of the weather preparedness and recovery plan within the timeframe allowed by the NPDES General Permit. Erosion and sediment control materials shall be stored on the project and protected from precipitation, runoff, and sunlight.

9. Stormwater Meeting.

A Stormwater Meeting shall be held after the preconstruction conference and prior to the beginning of work. The meeting shall convene at the project site. ALDOT construction personnel, including the Area Stormwater Coordinator and/or the Project QCP, the Project Manager, the Project QCI, the Contractor QCP (if applicable), the Contractor QCI, the Contractor's superintendent and any subcontractors that will be involved in clearing, earthwork, seeding or erosion and sediment control operations shall attend. The NPDES Permit, if applicable the U.S. Army Corps of Engineers Permit and/or U.S. Fish and Wildlife Service Clearance, ESCP, the CBMPP, the SWMP, clearing limits and sequence of construction shall be among the items discussed. Project discharge points, adjacent property and water bodies should be observed and discussed during the meeting. Any existing stormwater problems or issues should also be discussed and documented. The Contractor shall notify all subcontractors of the meeting and require their attendance. ALDOT will notify all applicable regulatory agencies.

10. Limit Of Exposure Of Erodible Material.

No more than 17 acres {7.0 ha} of erodible material shall be exposed at any time unless otherwise indicated on the plans by a project note that has been specifically approved by the State Construction Engineer. No increase in the limit of exposure will be considered after letting. If it is noted on the plans that the area of erodible material will be allowed to be greater than 17 acres {7.0 ha}, the Contractor shall include as part of the SWMP project specific details addressing management of the increased acreage during clearing and grubbing, excavation and embankment, vegetation establishment, temporary erosion and sediment control, drainage and construction of stormwater operations. Any approval to increase the area of exposure, including that shown on the plans, may be rescinded if the project is found by the Engineer to be noncompliant with the NPDES General Permit or environmental related contract requirements.

All areas of exposed erodible material will be considered as contributing to the limit of exposure until final required stabilization is installed or applied and erosion is controlled to the maximum extent practicable. The Contractor may submit a request for review and approval by the State Construction Engineer to exclude areas of exposure which are outside of the control of the Contractor and have been temporarily stabilized.

Requests for approval for unnecessary clearing may be considered only if provisions for erosion and sediment control are proposed to be implemented at the Contractor's expense.

(c) Notice of Intention to Start Work.

The Contractor shall provide the Engineer written notice of his intention to start work at least 72 hours in advance of beginning work and at least 24 hours in advance of beginning particular features of construction, such as driving piles, placing concrete, et cetera. Should prosecution of the work be discontinued by the Contractor with the consent of the Engineer, the Contractor shall give the Engineer at least 48 hours notice in writing before resuming operations.

(d) Continuous Prosecution of the Work.

The Contractor shall prosecute the work continuously and diligently in the order and manner set out in his schedule or prescribed by the Engineer. He shall provide sufficient satisfactory materials, labor, and equipment to guarantee the completion of the project in accordance with the plans and specifications within the time specified in the contract.

Should the Contractor fail to maintain a satisfactory rate of progress, the Engineer will require that additional forces and equipment be placed on the work to bring the project up to schedule and maintain it at that level. Failure to maintain the quality and progress of the work shall be cause for the

Engineer to withhold all estimates which are or may become due, until satisfactory quality and progress are maintained; or the contract may be defaulted as provided in Article 108.12.

(e) Unsatisfactory Progress.

Should the Contractor fail to maintain a satisfactory rate of progress in performance of the work, prior to expiration of the contract, the following regulation shall apply:

After preparation of the Contractor's monthly estimate, the Department will review the progress of the work. The dollar amount of the work performed will be the total dollar amount that has been paid minus the dollar amount of partial payments for stored materials. The percentage of work performed will be based on the dollar amount of work performed and the total contract amount. This will be compared to the percentage of contract time elapsed. If the percentage of the work performed, as compared to the percent of contract time elapsed, is behind by more than 25 percentage points, a warning notice of possible disqualification will be sent to the Contractor by certified mail, return receipt requested (appropriate credit will be allowed for any extension previously approved in conformity with Article 108.09). The warning notice will describe the unsatisfactory progress revealed by the computation and that ten days will be allowed from the date of receipt of the warning in which to bring his progress within the allowed 25 percent, complete the project, or furnish acceptable reasons why the Contractor should not be given a final notice of disqualification. At the end of the 10-day period, if the Contractor's progress is not within the allowed percentage, nor has acceptable reason been furnished to waive final disqualification, the Department will issue a final notice of disqualification.

108.05 Limitation of Operation.

The Contractor shall conduct the work at all times in such a manner and in such sequence as will insure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional section if the opening of such section is essential to public convenience.

108.06 Character of Workmen, Methods, and Equipment.

The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or by any Subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person, and shall not again be employed in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until compliance with such orders.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods of equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall

discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as result of authorizing a change in methods or equipment under these provisions.

108.07 Temporary Suspension of Work.

(a) Authority to Suspend.

The Engineer shall have the authority to suspend the work wholly or in part by written order to the Contractor for such period or periods as he may deem necessary due to either of the following reasons:

1. Failure on the part of the Contractor to carry out orders given or to perform any provision of the contract in which case time will be charged and no time extension will be granted, or
2. Unsuitable weather or other essential conditions of a highly unusual or unpredictable nature which he considers unfavorable for the suitable prosecution of the work in which case either time charges will be suspended or a time extension will be granted.

Upon suspension, the work shall be put in proper and satisfactory condition, carefully covered and properly protected, as directed by the Engineer. Reference is made to Article 105.13.

(b) Legal Stoppage or Termination.

Should the progress of the work be stopped by a temporary injunction, court restraining order, process of judgment of any kind directed to either of the parties hereto, then such period of delay will not be charged against the contract time. The State shall not be liable to the Contractor for the said legal delays of 120 calendar days or less, or for termination of the contract because of a legal order except as provided in Subarticle 108.14(b). Consideration will be given to properly documented added costs for a legal delay in excess of 120 calendar days, if submitted in accordance with Section 110, Claims. If a herein noted delay is of such duration as not to be in the best interest of the State, as determined by the Director, he may, by written order, terminate the contract in the same manner prescribed in Subarticle 108.14(c) for termination of a contract.

(c) Automatic Time Suspension.

Time will be suspended on calendar day projects during periods when no work can be performed on the project due to operational check periods or seasonal limitations when such periods are required by the specifications. Time will also be suspended for specification mandated curing periods for placement of permanent traffic stripe when all other work has been completed and the traveling public has full use of the highway.

(d) Suspension Considerations.

If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Engineer will notify the Contractor of his determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

108.08 Determination of Contract Time.

(a) General.

The number of working days or calendar days allowed or the calendar date specified for completion of the work included in the contract will be fixed by the Department, will be stated in the proposal and contract, and will be designated as the contract time.

(b) Beginning and End of Contract Time.

Contract time charges shall begin when the Contractor begins work on a pay item or on incidental work that will interfere with traffic, but in no case later than 15 calendar days after date of issue of "notice to proceed." Time charges shall end upon satisfactory completion of all pay items in the contract.

(c) Days Work Not Permitted.

The Contractor shall not permit work on any pay item to be done on Sundays and the following holidays: National Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day, except with written permission of the Engineer.

(d) Monthly Statement and Time Charges.

1. Contracts on a Work Day Basis.

For projects on a working day basis, the Engineer will furnish the Contractor a monthly time statement for the preceding month. This time statement will show the number of working days charged as outlined in the definition of Working Day in Subarticle 101.01(b), the number of working days in the contract, and the number of working days remaining to complete the contract.

Under the provisions of Article 105.01, the Engineer will determine the controlling item or items of work based on consideration of the Contractor's approved Schedule of Operations and the operations that should be in progress at the time to provide for the orderly completion of the work within the contract time. Consideration to not charging time will be given when delays of six hours or more occur when the causes for delays may be due to, but not restricted to the following:

1. Unavoidable causes beyond the control of the Contractor, without fault or negligence on his part.
2. Contractor's proof (in form of letters from suppliers) of inability to obtain materials due to a regionwide shortage of such materials.
3. Failure on the part of a utility company to diligently perform work not under the control of the Contractor.
4. Acts of the Department.
5. Recovery Time.
6. Strikes.

A working day will not be charged when the placement of hot mix asphalt is the controlling item of work and the start up operation is in an adjustment period unless the plant resumes production.

Upon receiving the monthly time statement, the Contractor shall review the statement and compare the time charges with his records. If the Contractor disagrees with the time charges on the statement, he shall file a written protest setting forth the reasons why he considers the monthly time statement incorrect. The Contractor is encouraged to file any such protest as soon as possible after receiving the time statement.

2. Contracts on a Calendar Day or Date Basis.

For projects on a calendar day or calendar date basis a similar statement will be furnished the Contractor indicating the number of calendar days remaining in the contract.

108.09 Extension of Contract Time.

(a) General.

An extension of contract time will be granted in the event the total cost of the completed work exceeds the total contract bid price. For the purpose of this item, the following costs will be excluded from the computation for total cost:

- Supplemental agreements, including compensation for delay claims, regardless of whether or not time extensions are allowed on the agreements ;
- Overruns of pay items included in Sections 665 and 672;
- Overruns of pay items included in a previously approved time extension request;
- Price adjustments for pavement smoothness;

- Bituminous material price adjustments;
- Cost adjustments for Construction Fuel;
- Adjustments due to the cost of construction fuel for HMA production;
- Incentive or disincentive payments; and
- Liquidated damages.

The extension of contract time shall be in the same ratio as the increase in the total cost.

If the Contractor finds it impossible for reasons beyond his control to complete the work within the contract time as specified or as extended in accordance with the provisions of this Article, he may at any time prior to the expiration of the contract time as extended, make a written request to the Engineer for an extension of time setting forth therein the reasons which he believes will justify the granting of his request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, he may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it were the original time for completion. If the Contractor disagrees with the decision of the Engineer, he may appeal directly, in writing, to the Director. The Director shall have final authority to approve or disapprove the request for an extension of time. The Director may, at his discretion, refer the appeal to the Claims Committee for a recommendation before making his decision. Reference is made to Section 110, Claims. Time extension requests will not be referred to the Claims Appeal Board.

(b) Contracts on a Working Day Basis.

When the time set for completion of the work is a number of working days, extensions of contract time will be handled as outlined in Subarticle (a) above.

(c) Contracts on a Calendar Day or Calendar Date Basis.

When the time set for completion of the work is a number of calendar days or a calendar date, working days are not applicable. Extension of time beyond the said calendar days or date will be made as follows:

When the notice to proceed is delayed more than 15 calendar days after execution of the contract, the date of completion will be extended the number of calendar days in excess of 15 days between the date of execution of the contract and the date of actual issuance of the notice to proceed.

Where work is suspended by order of the Engineer due to no fault of the Contractor, and time is not suspended, a time extension will be granted for the number of calendar days the work is so suspended.

A time extension will be granted as provided in Subarticle 107.08(b).

A time extension will be granted as outlined in the first paragraph of Subarticle (a) above.

The following are valid reasons for time extensions when delays due to these causes are considered by the Department of Transportation to be beyond the control of the Contractor:

1. Utility Work being performed by others not under the Contractor's control that prohibit the Contractor's construction operations from proceeding with the normal working forces he would otherwise employ in performing the controlling item, or items, of work which normally would be in progress at the time said Utility work is being accomplished.
2. Recovery time as defined in Article 101.01.
3. If in the course of work material delivery time is in excess of that normally anticipated due to demands beyond the supplying industries' capabilities provided such materials are necessary for the prosecution of the controlling items of work at that time and such can be substantiated by the Contractor in the form of letters from suppliers, the Department will consider a time extension for the delay caused by the lack of available materials.
4. If in the course of this project the Contractor feels he has been unjustly penalized because of delays in Departmental decisions, he may submit for consideration by the Engineer written specific data covering the item or items and the time element involved. The Department will consider only an extension for the actual work delay caused by the delay in obtaining a decision.
5. If in the course of the work, strikes occur while the Contractor is working in good faith and such was not caused by action of the Contractor, the Department will consider a time extension for the delay caused by the strike.

When allowing a time extension under the provisions noted in this Subarticle, consideration in determining the adjusted completion date for the work will be given to allow additional time to compensate for seasonal conditions, weather and other factors not under control of the Contractor. Should the Contractor, after exercising a concerted effort to diligently prosecute the work taking full advantage of every available work day, not be able to complete the work within the adjusted completion time because of non-availability of days in which work can be performed, the Department may consider an additional extension of time for the work.

108.10 Failure to Complete Work Within Contract Time.

Should the Contractor, or in case of default, the surety, fail to complete the work within the time stipulated in the contract or the adjusted time as granted under the provisions of Article 108.09, a deduction for each calendar day or work day that any work shall remain uncompleted, an amount indicated by the Liquidated Damages Schedule shown in Article 108.11 or provided in the contract documents shall be deducted from any monies due the Contractor on monthly estimates. Any adjustments due to approved time extensions or overruns in the contract amount will be made on the monthly, semi-final or final estimate as may be appropriate.

Liquidated damages assessed as provided in these Specifications is not a penalty, but is intended to compensate the State for increased time in administering the contract, supervision, inspection and management, particularly that management and inspection which requires maintaining normal field project management forces for a longer time on any construction operation or phase than originally contemplated when the contract period was agreed upon in the contract.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

108.11 Schedule of Liquidated Damages.

Original Contract Amount		Liquidated Damages Daily Charge	
More Than	To and Including	Calendar Day or Fixed Date	Work Day
$ 0	$ 500,000	$850	$1700
500,000	1,000,000	1200	2400
1,000,000	2,000,000	1500	3000
2,000,000	10,000,000	2050	4100
10,000,000	----------	3100	6200

When the contract time is on the calendar day or date basis, the schedule for calendar days shall be used. When the contract time is on a work day basis, the schedule for work days shall be used.

108.12 Default of Contract.

If the Contractor:

1. Fails to begin the work under the contract within the time specified in the "Notice to Proceed," or
2. Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or
3. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
4. Discontinues the prosecution of the work, or
5. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
6. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
7. Allows any final judgement to stand against him unsatisfied for a period of 10 days, or
8. Makes an assignment without the consent of the surety and approval of the Department, or
9. Fails to furnish documentation necessary for final acceptance and payment, or
10. Fails to carry out provisions of the contract, or
11. For any other cause whatsoever, fails to carry on the work in an acceptable manner,

the Engineer will give notice in writing to the Contractor and his surety for such delay, neglect, or default.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Department will, upon written notification from the Engineer of the fact

of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Department may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the Engineer will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due said Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the Surety shall be liable and shall pay to the Department the amount of such excess.

Notice to the Contractor shall be deemed to be served when delivered to the person in charge of any office used by the Contractor, to his representative at or near the work, or by certified letter, return receipt requested, addressed to the Contractor at his last known place of business.

In addition to the provisions provided in this Article, failure of the Contractor to sign the final estimate within the time limits prescribed in Subarticle 109.12(d) will be classified as a default.

108.13 Blank.

108.14 Termination of Contractor's Responsibility.

(a) General.

The Contract will be considered complete when all work has been finished, the final inspection made by the Engineer, the project accepted by the Department, the necessary advertisements published, all in accordance with the provisions of Article 105.15, and the final estimate paid. Upon completion of the above, the Contractor's responsibility will then cease, except as set forth in his bonds.

(b) Special Conditions.

Should the Department find that the Contractor is unable to complete his contract work due to the inability to obtain specified materials or satisfactory substitutes therefor or labor, because of laws, rules or regulations placed into effect or the inability of industry to produce specified materials within a reasonable time; the Director may, by written notice, relieve the Contractor from that portion of the contract which cannot be performed. Also, should the State determine that further prosecution of the work on a project will not be in the best interest of the public, the Director may, by written order, eliminate or delete any or all remaining items of work on a contract.

The deletion or elimination of work under the above conditions will in no way affect the unit prices bid in the contract. Work actually performed will be paid for at the contract unit prices. Should relief from performance of the contract or any portion thereof directly cause the loss of any work or materials already furnished under the terms of the contract, the Contractor will be reimbursed for the actual cost of salvaging the materials or as mutually agreed to.

Materials obtained by the Contractor, which have been inspected, tested and accepted by the Engineer but not incorporated into the work may, at the option of the Engineer, be purchased in accordance with the provisions of Article 109.06.

If, by the deletion of work items, the volume of work completed is too small to compensate for the organization and moving of equipment to and from the work, consideration will be given to reimbursement for actual costs thereof; the intent being that an equitable settlement be made; compensation for this, however, shall not exceed the percentage differentiation between plan quantities and actual quantities performed, and if 75% of the estimated work was performed, no compensation for the organization and moving of equipment to and from the work will be allowed. In no event will a claim for loss of anticipated profits be considered. The deletion or elimination of work under the above conditions shall in no way relieve the Contractor from his responsibility for work actually performed nor any just claims as a result thereof.

Final termination of the contract shall be as noted in Subarticle (a) above, for the work completed.

(c) National Emergency.

The Director may, by written order, terminate the contract or a portion thereof when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual units or items of work completed at the contract

unit price bid, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits will be considered.

Reimbursement for organization of the work and moving equipment to and from the job will be considered where the volume of work completed is small to compensate the Contractor for these expenses under the contract unit prices, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Engineer, and are not incorporated in the work may, at the option of the Engineer, be purchased from the Contractor in accordance with the provisions of Article 109.06.

Final termination of the contract shall be as noted in Subarticle (a) above, for the work completed.

SECTION 109
MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities.

(a) General.

All work acceptably completed under the contract will be measured by the Engineer according to United States Standard Measures and Weights, unless otherwise provided on the plans or in the special provisions. No local rules or customs will be followed or considered.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, lumber, etc., and these items are identified by gage, weight {mass}, section, dimensions, etc., such identification will be considered to be nominal weights {masses} and dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

(b) Base Layer and Pavement Areas.

All longitudinal measurements for computing area of base layers and pavements will be made along the actual surface of the roadway and not horizontally and no deductions will be made for individual fixtures in the roadway having an area of nine square feet {one square meter} or less. For all transverse measurements for area of base layers and pavements, the dimensions to be used in calculating the pay area shall be the neat dimensions shown on the plans or directed.

(c) Structures.

Structures will be measured according to neat lines shown on the plans or as ordered in writing, unless otherwise provided elsewhere in the specifications or in the special provisions.

(d) Excavation.

In computing volume of excavation, embankment and borrow, the average end-area or other acceptable method will be used. It is stipulated and agreed that the electronic computer and/or planimeter shall be considered as instruments of precision adapted to the computation and measurement of these volumes and areas. Completed final cross sections and computed quantities will be made available to the Contractor upon request but shall not be removed from the Engineer's office.

(e) Linear Measurements.

All items which are measured in linear measurement by the foot {meter}, such as pipe culverts, guardrail, underdrains, etc., will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans or indicated in these specifications.

(f) Gage.

The term "Gage", when used in connection with the measurement of plates, shall mean the U.S. Standard Gage; when used with wire, shall mean U.S. Steel wire gage.

(g) Blank.

(h) Weight {Mass} Measurements.

1. General.

The term "ton" shall mean the short ton {metric ton} consisting of 2,000 pounds avoirdupois {1000 kg}.

Scales furnished by the Contractor shall meet all requirements currently adopted by the Alabama Department of Agriculture pertaining to weighing or measuring devices.

Scales shall be tested and inspected by a service agent currently registered with the Alabama Department of Agriculture. The time between inspections shall not exceed six months. In addition, any time a plant is moved or substantially modified, the scales shall be inspected. The inspection report shall be uploaded to the Alabama Department of Agriculture's reporting website and a copy sent to the Area in which the scale is located. It is the Contractor's responsibility to ensure weighing devices are maintained in proper working condition during use. Devices that are found to be out of compliance will not be used until such time corrections are made to comply with regulations and they are recertified. The Engineer will reject them for use on the project until they are recertified. Weights {Masses} above the acceptable capacity of a set of scales will not be acceptable.

2. Weight {Mass} Measure for Pay Purposes.

If material is shipped by rail, the car weight {mass} may be accepted provided that only the actual weight {mass} of material is paid for and is certified by a car weight {mass} obtained from a certified scale after the unloading. However, car weights will not be accepted for steel reinforcement, structural steel or materials that are to pass through a mixing plant.

Trucks used to haul material being paid by weight shall be measured empty daily, with the driver in the truck, to establish a daily tare weight. Each truck shall also bear a plain legible identification number.

Commercial materials, except reinforcing steel and structural steel, which are measured by weight {mass} for pay purposes shall be measured by a qualified "Weighmaster*" using acceptable weight tickets. As a minimum, the weight ticket shall contain the following:

1) Name of the Contractor and material producer.
2) Project Number and County.
3) Truck number.
4) Contract item number and item name.
5) Date and time of loading.
6) Gross, tare, and net weights.
7) Weighmaster's signature. (May be electronically generated).
8) Any additional information as required of the Contractor or material producer for participation as a Qualified Source as given in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual unless furnished on a separate applicable BMT Certificate of Compliance.

For measurement systems capable of measuring net weight directly from the measuring hopper, the gross and tare weights will not be required. In lieu of bulk weight, the Department will accept weights of materials normally sold in bagged form (i.e. fertilizers, cement, etc.).

It shall be the sole responsibility of the Contractor to ensure that a weight {mass} ticket is delivered to the project with each load. Weight tickets will not be accepted after the truck has left the project.

*Weighmasters must be qualified in accordance with the provisions of Section 8, Chapter 16, of the Code of Alabama, 1975, or in case of material purchased out of State complying with the appropriate State laws, rules and regulations for Weighmasters of the State involved. A copy of the "Weighmaster's Certificate" shall be furnished the Engineer and additionally a copy shall be displayed in a conspicuous place in the vicinity of the measuring operations.

3. Weight {Mass} Measurement for Proportioning, etc. of Materials.

Scales used for proportioning mixtures within mixing plants shall comply with the following unless otherwise noted:

a. Asphalt Mixing Plants.

Scales shall meet current compliance regulations according to Alabama Department of Agriculture requirements and be visible to the plant inspector on the mixing platform.

b. Concrete Mixing Plants or Units.

Scales shall meet current compliance regulations according to Alabama Department of Agriculture requirements. Separate scales shall be provided for bulk cement and for bulk fly ash, as provided in Article 815.11.

c. Base Course Mixing Plants.

Measuring equipment shall meet the requirements of Subitem b. above with separate bins for each size aggregate and separate bins and scales for additives (calcium chloride, cement, etc.).

(i) Loose Measurement (Volumetric).

All materials to be measured by the cubic yard {cubic meter}, "loose measurement" or "measured in the vehicle", shall be hauled in approved vehicles and will be measured therein at the point of delivery. No allowances will be made for the settlement of material in transit. Approved vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. Each approved vehicle must bear a plainly legible identification mark indicating the specific approved capacity. All approved vehicles shall be loaded to not less than their water level capacity when they arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specifically approved quantity for the hauling vehicle, measured as specified herein, will be rejected and shall be removed from the work. If rejected, no compensation will be allowed for the rejected load.

(j) Conversion of Weight {Mass} to Volume.

When requested by the Contractor and approved in writing, material specified to be measured by the cubic yard {cubic meter} may have its weight {mass} determined and such weight {mass} will be converted to cubic yards {cubic meters} for payment purposes. Ratios for conversion from weight {mass} measurement to volume measurement will be determined periodically by the Engineer. Each ratio as determined shall be agreed to by the Contractor before such method of measurement will be used.

(k) Timber.

Timber will be measured by the thousand feet board measure (MBM) {cubic meter} actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thickness and the extreme length of each piece.

(l) Lump Sum.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the contract.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

109.02 Measurement of Asphaltic Material.

(a) Weight {Mass}.

Asphaltic materials shall be measured in tons {metric tons} or gallons {liters} as specified on the plans or in the proposal. If measured by weight {mass}, each tank truck, drum or distributor shall have its weight {mass} obtained as the material is delivered to the location of the work, and the container vehicle shall have its weight {mass} obtained immediately after emptying; except that when this method cannot be used other means of accurately measuring the material may be substituted with permission of the Engineer.

(b) Gallonage {Liters}.

When specified on the plans or in the proposal, bituminous material will be measured by the gallon {liter} in the railroad car, tank truck, distributor tank, or drums. Each railroad tank, tank truck, drum or distributor tank of bituminous material delivered for the project will be measured. The measurement shall be taken when the bituminous material is of a uniform temperature and free from air bubbles.

(c) Temperature Correction.

The volumetric measurement of the bituminous material will be based upon a temperature of 60 °F {16 °C}, using the following correction factors:

0.00035 per degree F {0.00063 per degree C} for petroleum oils having a specific gravity above 0.966 at 60 °F/60 °F {16 °C/16 °C};

0.00040 per degree F {0.00072 per degree C} for petroleum oils having a specific gravity between 0.850 and 0.966 at 60 °F/60 °F {16 °C/16 °C};

0.00025 per degree F {0.00045 per degree C} for emulsified asphalts.

109.03 Scope of Payment.

(a) Quantities.

The quantities listed in the bid schedule do not govern final payment. Payments to the Contractor for contract items will be made for the actual quantities of these items performed in accordance with the plans and specifications. If upon completion of the construction these actual quantities show an increase or decrease from those in the proposal, the contract unit prices will still govern except where modified by supplemental agreement or allowance made as provided in Articles 104.02 and 104.03.

Quantities included in supplemental agreements will be paid for as stipulated therein. Force account work will be paid for as provided in Article 109.04.

(b) Basis of Payment.

The Contractor shall accept the compensation as herein provided, in full payment for furnishing all materials, labor, tools, equipment and incidentals necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements except as noted in Article 107.17, or from any unforeseen difficulties which may be encountered during the prosecution of the work and until its final acceptance; also for all risks of every description connected with the prosecution of the work.

(c) Unit Price Coverage.

In cases where the basis of payment clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or materials essential to the item, this same work or materials will not be measured or paid for under any other pay item which may appear elsewhere in the specifications. Reference is made to Item 101.01(c)1.

(d) Repair or Renewal of Defective Work.

The payment of any current estimate shall in no way affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

(e) Bituminous Material Price Adjustments.

1. Asphalt Index.

The contract unit prices for bituminous materials shall be based on the asphalt prices at the time of opening bids. The Department will establish a monthly "Asphalt Index" to address fluctuations in the cost of the bituminous materials during the life of the project.

The index will be composed of the following four entries:

- PG Asphalt (for all grades without polymer);
- PG Asphalt with Polymer (for all grades with polymer);
- Emulsified Asphalt (for all grades without polymer and cutback asphalts);
- Emulsified Asphalt with Polymer (for all grades with polymer).

2. Usage and Payment.

Adjustments in compensation will be computed each month that bituminous materials are used in the work. Bituminous plant mix bases and pavements, surface treatments and tack coat are the only types of bituminous materials for which a price adjustment will be computed. Adjustments in compensation will be based on an index that is a monthly price per gallon for the bituminous material.

Before the expiration of contract time (plus approved time extensions) the dollar amount of adjustment will be determined by multiplying the increase or decrease of the current (current estimate month) index from a "base index" by the number of gallons of bituminous material used in the work during the period covered by the monthly estimate. The base index will be the value of the index for the month in which the project is let. This same index will apply to bituminous materials added to the contract by supplemental agreement after letting.

After the expiration of contract time (plus approved time extensions) two calculations of a potential price adjustment will be made. The first calculation will be made using the current index and the base index. The second calculation will be made using the index during the month that contract time (plus approved time extensions) expired and the base index. The amount of the price adjustment for the current estimate period will be the smallest amount of an increase in compensation if both calculations are an increase in compensation. The amount of the price adjustment will be the largest amount of a decrease in compensation if both calculations are a decrease in compensation. The amount of the price adjustment will be the decrease in compensation if one of the calculations is an increase in compensation and the other calculation is a decrease in compensation.

The amount of asphalt will be calculated as follows:

- Bituminous Plant Mix Bases and Pavements - the number of gallons {liters} of new bituminous material required by the approved job mix formula. A conversion factor of 8.51 pounds per gallon {1.02 kg/L} will be used for figuring quantities. No measurement for adjustment will

be made for the amount of asphalt rejuvenator used or for the amount of bituminous material recovered and used in surface recycling operations.

- Surface Treatments - actual gallons {liters} of asphalt used within specification requirements with volumetric correction to 60 °F {16 °C} as per Subarticle 109.02(c).
- Tack Coat - actual gallons {liters} of asphalt used within specification requirements with volumetric correction to 60 °F {16 °C} as per Subarticle 109.02(c).

(f) Adjustments Due to Cost of Construction Fuel for HMA Production.

Changes in the compensation due the Contractor will be made by the Engineer to address changes in the cost of fuel required for the production of Hot Mix Asphalt (HMA) in a plant. The changes in compensation will be made based on a monthly index of the cost of fuel determined by the Department.

A monthly HMA production fuel index will be established based on the average area terminal price reports for No. 2 fuel and No. 6 (3.0 % S) fuel of the "Platts Oilgram Price Report" published during the week in which the first day of the month occurs.

Before the expiration of contract time (plus approved time extensions) the dollar amount of adjustment will be determined by multiplying the increase or decrease of the current (current estimate month) index from the base index by the number of gallons of fuel that are used in the production of the HMA during the period covered by the monthly estimate. The number of gallons of fuel required for the production of the HMA shall be 2.0 gallons per ton {8.3 L per metric ton} of HMA produced during the estimate period. The base index will be the value of the index for the month in which the project is let.

After the expiration of contract time (plus approved time extensions) two calculations of a potential price adjustment will be made. The first calculation will be made using the current index and the base index. The second calculation will be made using the index during the month that contract time (plus approved time extensions) expired and the base index. The amount of the price adjustment for the current estimate period will be the smallest amount of an increase in compensation if both calculations are an increase in compensation. The amount of the price adjustment will be the largest amount of a decrease in compensation if both calculations are a decrease in compensation. The amount of the price adjustment will be the decrease in compensation if one of the calculations is an increase in compensation and the other calculation is a decrease in compensation.

Changes in compensation will be made for the number of tons {metric tons} of HMA placed and paid for in accordance with the requirements given in the following Sections:

Section 327, Plant Mix Bituminous Base;
Section 404, Paver-Laid Surface Treatment;
Section 420, Polymer Modified Open Graded Friction Course;
Section 423, Stone Matrix Asphalt;
Section 424, Superpave Bituminous Concrete Base, Binder, and Wearing Surface Layers.

109.04 Extra and Force Account Work.

(a) General.

The Contractor will receive and accept payment for work performed under his contract either as contract items of work or as extra work. Contract items of work will be paid for at the unit prices stipulated in the contract. Extra work will be paid for at the unit prices or lump sum stipulated in supplemental agreement, or on a force account basis. Supplemental agreements shall be executed in accordance with Subarticle 104.03(b). When prices are negotiated for payment by supplemental agreement, satisfactory proof of administrative markups for profit, overhead, and other costs may be required by the engineer. Extra work performed on a force account basis will be compensated for in the following manner.

When requests for compensation are granted through the claims process outlined in Section 110, the Contractor will receive and accept payment as contract items of work, with consideration given to submitted increases in associated costs, and/or in the following manner equivalent to a force account basis, as is deemed appropriate during the claim review.

(b) Force Account Basis.

1. Labor.

For all labor, foremen, and superintendents, employed on the force account work, the Contractor shall receive the agreed hourly wages or scale for the number of hours the said laborers, foremen, and superintendents were actually engaging in or directly supervising such work. No allowance will be made for general superintendence. Hourly wages for salaried employees will be based on a 40-

hour work week. The wages or scale shall be comparable to the wages or scale paid by the Contractor for work of a like nature on his contract pay items and shall be agreed upon in writing by the Contractor and Engineer before the said force account work is begun. The Contractor shall furnish copies of certified payrolls, or similar on projects that do not require such, as satisfactory evidence of labor costs.

To this sum shall be added an amount equal to twenty-five percent (25%) thereof.

No additional pay beyond the agreed hourly scale will be allowed for "overtime work" unless such overtime work is authorized in writing by the Engineer.

Labor costs will be allowed for travel time to and from the jobsite when that travel is specifically for the purpose of accomplishing force account work. Travel time shall be established and approved by the Engineer prior to beginning of the work. Travel time costs shall be validated with certified payrolls.

Per diem or daily subsistence will be allowed when those costs are directly related to force account work and a part of the Contractor's usual and customary expenses. An additional 5 percent will be added to the per diem or daily subsistence costs.

2. Bond, Insurance and Tax.

For public liability and property damage insurance and workmen's compensation insurance premiums, increased bond premiums, unemployment insurance contributions and social security taxes, the Contractor shall receive the actual cost, to which no percent shall be added; in addition on projects which the State Gross Receipt Tax is applicable, may include said tax. The Contractor shall furnish satisfactory evidence of the rates paid for such bond, insurance, and tax.

Unemployment insurance contributions, social security taxes, and other fringe benefits are understood to be included in the base labor rate and no additional markup will be applied. The workmen's compensation insurance rate shall be applied to the base labor cost prior to any markups. The public liability and property damage insurance rate, bond rate, and State Gross Receipt Tax shall be applied to the overall total for additional compensation.

3. Materials.

For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the work (exclusive of machinery rentals as herein set forth) to which cost fifteen percent (15%) will be added. The Contractor shall furnish copies of paid invoices as satisfactory evidence of material costs.

4. Equipment.

For rental rates of equipment (other than small tools) authorized by the Engineer for use on force account work, the Engineer will use the latest publication of EquipmentWatch Cost Recovery (formerly Rental Rate Blue Book), by EquipmentWatch, a division of Penton Business Media, Incorporated to determine payment to the Contractor. Payment will be made for the actual time that the authorized equipment is in operation on the force account work, including travel time to and from the jobsite, when that travel is specifically for the purpose of accomplishing force account work. The hourly rate for each piece of equipment will be the monthly rate shown in the equipment table divided by 176. Weekly and daily rates will not be used. In addition, for equipment solely dedicated to the force account work, consideration will be given to paying standby cost. The Contractor shall furnish daily records of equipment hours and identifying information including make, model, and model year. Operating rates and standby rates for computing the equipment payment will be determined as follows:

Operating rates. The hourly rate will be multiplied by the appropriate rate adjustment factor and regional factor shown in the Rate Adjustment Table and on the Regional Adjustment Map, respectively, to obtain the adjusted hourly rate. The estimated operating cost/hour from the equipment table will be added to the adjusted hourly rate to establish the operating rate.

Standby rates. The use of a standby rate is appropriate when equipment has been ordered to be available for force account work but is idle for reasons which are not the fault of the Contractor. The standby rate will be determined by multiplying the adjusted hourly rate by 0.50.

Operating rates will be used only when the equipment is actually being used. Standby rates will be used under the following conditions:

a. The equipment must be totally dedicated to the force account work and not used intermittently on other work.

b. Standby cost will not be considered until after the equipment has been operated on the force account work.
c. If the equipment is dedicated for force account for a full calendar work week, the standby time will be 40 hours minus the operating time for the week. If the difference in these two figures is zero or less, there will be no payment for standby.
d. If the equipment is dedicated for force account for a partial week, the standby time will be computed on a daily basis. The standby time per day will be 8 hours minus the operating time for the day. If the difference in these two figures is zero or less, there will be no payment for standby.

The above will apply without further adjustment if overtime work is approved by the Engineer.

The above shall be full compensation for all equipment costs except operator cost. Payment for operators will be under Item 109.04(b)1, Labor.

If equipment is required that is not listed in the Rental Rate Blue Book, then payment will be made for that equipment based on a certified or paid invoice for the period of time covered by the invoice. In this case, the equipment must be totally dedicated to the force account work and no distinction will be made between operating cost and standby cost. If this equipment is owned by the Contractor, then rental rates for operating and standby costs shall be agreed upon between the Contractor and Engineer prior to its use.

5. Professional Services

Compensation for professional services shall be on an invoice basis. Labor and equipment costs will not be calculated separately for professional services.

6. Costs Not Allowed.

No additional allowance shall be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

7. Administrative Allowance.

When force account work is accomplished by an approved subcontractor or professional service, the Contractor shall receive, as compensation for administration costs, an amount equal to–five percent (5%) of the total amount paid under items 1, 2, 3, 4, and 5 of this Subarticle for force account work accomplished by an approved subcontractor or professional service.

8. Compensation.

The compensation as set forth in this Subarticle shall be received by the Contractor as payment in full for extra work done on a force account basis. Said compensation shall cover all work, profit, administrative costs, general superintendence costs, and incidental costs of whatever nature incurred in the work whether performed by the Prime Contractor or an approved subcontractor. At the end of each day, the Contractor's representative and the Inspector shall compare records of the cost of work done as ordered on a force account basis.

9. Statements.

No payment will be made for work performed on a force account basis until the Contractor has furnished to the Engineer duplicate itemized statements of the cost of such force account work, detailed as to the following:

a. Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman.
b. Designation, dates, daily hours, total hours, rental rate and extension for each truck and other unit of machinery and equipment.
c. Quantities of materials, prices, and extensions.
d. Transportation of materials.
e. Travel time for equipment.
f. Cost of public liability and property damage insurance and workmen's compensation insurance premiums, increased bond premiums, unemployment insurance contributions, and social security tax.

Statements shall be accompanied and supported by original receipted invoices for all materials used and transportation charges, provided that, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the original invoices the statements shall contain or be accompanied by an affidavit of the Contractor certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.05 Compensation for Altered Quantities.

When the accepted quantities of work vary from the quantities in the bid schedule, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the actual quantities of work done. No allowance or other adjustment, except as provided in Article 104.02, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor or from any other cause.

Additional work caused by alterations of plans or changes in character of work will be paid for by supplemental agreement or on a force account basis.

109.06 Omitted Items and Cancelled Work.

(a) Elimination of Items.

Should any items contained in the proposal be found unnecessary for the proper completion of the work contracted, the Engineer may eliminate such items from the contract, and such action shall in no way invalidate the contract and no allowance will be made for items so eliminated in making final payment to the Contractor except for such actual work as may have been done, materials actually purchased and bona fide equipment costs incurred for such eliminated item prior to notification of the elimination of the items.

(b) Unused Materials.

For materials ordered and delivered for the unfinished portion of such cancelled or omitted items, the State will pay actual certified cost (material and handling or transporting cost) plus fifteen percent for both overhead and gross receipt tax charges; no anticipated profit will be considered. Material paid for shall become the property of the State and shall be disposed of as directed by the Engineer.

109.07 Partial Payment.

Once each month the Engineer will make an appropriate estimate on the regulation form of the work or portion of the work completed and the value thereof based on the contract Unit Prices, or proportional part thereof for Lump Sum items, less any assessed liquidated damages or other designated deductions.

This estimate may, if requested in writing by the Contractor and approved by the Engineer, include cost of certain commercial non-perishable items such as, but not limited to, base aggregates, reinforcing steel, bridge piling, structural steel, prefabricated bridge components, traffic signal equipment, electrical equipment, fencing materials, sign materials and others as may be authorized by the Engineer within the following limitations:

1. The location of the storage site shall be at the project site or other designated location in the vicinity of such construction whenever practical. Off-site storage may be approved if the Engineer considers off-site storage to be more practical. In either case, all conditions of this Article concerning stored (stockpiled) material shall be met. Departmental Form C-21 will be used to document all payments for stored material.
2. All material approved for payment in storage must be manufactured for specific use on the project. It shall be stored in accordance with good construction practices, and shall be separated from other materials where it can be inventoried at any time. No payment will be made on any material which does not conform with the requirements of the plans and specifications. The Contractor will be responsible for the security of all storage sites.
3. An individual payment and the accumulated payment, unless otherwise provided under a specific item of work, shall be the smaller of the following two dollar amounts:
    - 100% of the certified invoice cost (including applicable taxes) plus gross receipts tax for the materials actually delivered to the approved storage site or;
    - 75% of total bid price for the item of which the material is a part.

An invoice or an accumulation of invoices for each eligible pay item must total $2,500 or more before consideration will be given for making partial payment. All invoices shall be certified by the Contractor or the supplier of the material. The certification shall be shown on the invoice and shall read as follows: "I do hereby certify that this is a true and correct invoice." This wording shall be followed by the signature of an authorized representative of the Contractor or the supplier.

4. After payments are placed on monthly estimates, the Contractor shall furnish the Project Manager with copies of certified paid invoices from the suppliers of the materials. The certification shall be shown on each invoice and shall read as follows: "I do hereby certify that this is a true and correct invoice and has been paid." This wording shall be followed by the signature of an authorized representative of the supplier. Failure to furnish these certified paid invoices within thirty (30) days from the date of issuance of the monthly payment (check) covering the estimate for which the payment of materials was made by the State will result in the deletion of the payment from the next estimate following the expiration of said 30-day period.
5. As stockpiled materials are incorporated into the work, proportional deductions will be made in the monthly estimate for such partial payments.
6. Partial payment for materials on hand will not constitute acceptance and any faulty material will be rejected even though previous payment may have been made. The Contractor shall be solely responsible for furnishing and incorporating acceptable materials into the work and for any loss or damage regardless of the cause, for any material on which partial payment is made.
7. Transportation charges for delivery of eligible materials to the approved storage site may be included in partial payments for stockpiled materials if properly documented. Such charges may be included in the materials invoice or handled as a separate invoice, whichever is appropriate.

The estimate, less any payments previously made, will be certified by the Director for payment provided progress and quality of work is satisfactory and in conformity with Subarticle 108.04(b).

No monthly payment will be required to be made when the amount due on the project is less than $2,500. A statement of any sum due the State or County for equipment, labor, or supplies furnished under the provisions of these Specifications will be furnished along with the estimate and the amount of same will be deducted from the estimate before payment is made by the State.

The payment of any monthly estimate for any portion of the work as provided in the Specifications shall in no way affect the obligation of the Contractor to complete the work in accordance with the contract

109.08 Payments to Subcontractors.

Retainage shall not be withheld from payments owed to subcontractors or lower tier subcontractors.

The Prime Contractor shall make payment to all subcontractors, for the portion of the work satisfactorily performed by the subcontractors, within 14 calendar days (including Saturdays, Sundays, and holidays) of the Contractor's receipt of a partial payment from the ALDOT.

The Prime Contractor shall submit to the Project Manager a notarized certification of payment signed by an authorized company representative, for each estimate period. This certification shall read "Company's Name paid all subcontractors active on the project for Estimate Period No. ____ within 14 calendar days of the receipt of the partial payment covering said estimate period. All subcontractors were paid in full based on the said estimate and any subcontractor invoices received with the following exceptions: list any exceptions and provide an explanation." The certification shall be submitted within sixty calendar days of the close of the estimate period for which it applies. Failure to furnish the certification in a timely manner may result in the withholding of further monthly payments or other punitive action until the delinquent certifications have been submitted. Should an ALDOT audit reveal that the Contractor did not make payments as stated in the certification, ALDOT will take punitive action against the Contractor. This action may include disqualification from bidding for a minimum period of six months.

109.09 Payment for Work.

Payment for work will be made by the State by warrants drawn against State funds that are legally available for such work.

All monies payable under the contract, or any part thereof, will be paid to the Contractor in accordance with the provisions of these specifications, and no assignment or order executed by the Contractor directing payment of any portion or all of such funds to any other person or persons will be recognized by the State unless such assignment or order specifies the amount to be so paid and the purposes for which the assignment or order is given. Such assignment or order shall have attached thereto, by endorsement or otherwise, the consent of the surety. No such assignment or order will be binding on the State.

109.10 Disputed Claims for Extra Compensation.

Claims shall be handled as provided in Section 110, Claims.

109.11 Time Limit for Final Adjustment.

It is understood that the Director will not be bound to consider applications for correction of estimates and payments, including assessed liquidated damages, after the Contractor has signed his final estimate, or after 30 days from the date when the final estimate is submitted to the Contractor for his signature or approval, unless in the latter case the Contractor submits written request within the 30-day period for adjustment of estimates and payment, including assessed liquidated damages.

109.12 Final Payment.

(a) Final Quantities.

Within 60 calendar days after the final inspection as outlined in Article 105.15, the Engineer will prepare the list of final quantities for the various items of work performed. The Engineer will submit by certified letter, return receipt requested, the list of final quantities to the Contractor for his review and concurrence.

The Contractor will have 45 calendar days from the date of receipt to submit either written concurrence of the final quantities or a written statement of disagreement. The written statement of disagreement shall contain a list, item by item, of the quantities that the Contractor does not agree with and his reasons for disagreement on each item's final quantity. Failure by the Contractor to furnish the written statement within 45 calendar days shall be prima facie evidence that the Contractor considers the submitted final quantities to be satisfactory and waives any further consideration of the final quantities.

Upon notice from the Contractor of a dispute in quantities, the Engineer will promptly attempt to resolve the differences. If the Engineer is not able to reach an agreement with the Contractor the matter will be referred to the Director for resolution. The Director may refer the dispute to the Claims Committee for a recommendation before making a final decision. Issues of disputed quantities will not be referred to the Claims Appeal Board.

If the Contractor requests the Department to make a resurvey which will require additional field and/or office work, the Director may grant the request with the understanding that the Contractor will be paid the final survey and/or computed quantities whether they be more or less than the original final quantities. If a resurvey is made at the Contractor's request, the Contractor and the Department shall share equally the additional cost of the resurvey and the Contractor's portion of this cost will be deducted from the final estimate.

(b) Claims.

All claims for extra compensation will be handled in accordance with Section 110, Claims.

(c) Final Estimate Documentation.

Prior to submission of the final estimate voucher to the Contractor for his signing, the Contractor shall furnish the following documentation, as applicable:

1. A non-resident contractor must provide a certified "statement of good standing" from the State Department of Revenue and the appropriate County and/or City authority. This statement certifies that the non-resident contractor had paid all taxes due and payable to the State of Alabama or any political subdivision thereof. See Section 39-2-12 of the Alabama Code.
2. Proof of publication of advertisement of project completion as per Item 105.15(c).
3. A signed affidavit attesting that all known debts for labor and materials used on the project and all approved subcontractual obligations associated with the construction of the project have been paid or will be paid within 5 days after final payment. The affidavit shall be on a standard form furnished by the Department.

Failure by the Contractor to furnish any of the above documentation will be cause for the Engineer to declare the Contractor to be in default as per Article 108.12.

(d) Payment.

Upon resolution of the final quantities, all claims, and receipt of the above listed documentation, and written notice of final acceptance, the final estimate voucher will be prepared taking into consideration all prior partial payments. The Engineer will submit by certified letter, return receipt requested, the final estimate voucher to the Contractor for his signing. The Contractor shall have 30 calendar days after receipt of the voucher to sign and return the same for processing for final payment.

Should the Contractor fail to sign and return the voucher within the 30 days, he will be declared in default in accordance with Paragraph 5 of Article 108.12.

Upon receipt of the signed final estimate voucher or default action taken per Paragraph 5 of Article 108.12, the Department will issue a warrant in the amount due the Contractor. The final warrant will be issued to the Surety in cases where the Contractor is placed in default under Article 108.12 and the contract is placed in the hands of the Surety. By agreement it is hereby stipulated that the Contractor and the Surety are forever barred and estopped from any recovery of claims whatsoever against the Department under the terms of the contract.

SECTION 110
CLAIMS

110.01 General.

When filing a claim, the Contractor shall follow the procedures set forth in this Section. Any claims by a Subcontractor must be submitted to the Contractor. The Contractor may then submit the Subcontractor's claim on their behalf following the same procedures, or otherwise choose to accept full responsibility for the Subcontractor's claim and any associated costs, delays, or impacts to the project.

110.02 Notice of Intent.

In any case where the Contractor deems that extra compensation is due him for additional cost not clearly covered in his contract and not ordered by the Engineer as extra work as defined herein, the Contractor shall notify the Construction Bureau in writing, with copy to the Project Manager, of his intention to make claim for such extra compensation.

The written notice of intent to file a claim shall be furnished to the Engineer prior to the time the contested work is started. Oral notification by the Contractor and confirmed in writing by the Contractor within three calendar days, will be accepted as complying with this requirement. Electronic submission of said notification will be accepted.

The written notice of intent to file a claim shall set forth the reasons the Contractor believes additional compensation will be due, the nature of cost involved and insofar as possible the total amount of the claim.

The Contractor hereby agrees to waive any claim for additional compensation if notification, as provided in the foregoing, is not furnished or the Engineer is not provided facilities by the Contractor for keeping account of actual costs.

Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, is not evidence of the validity of the claim. A separate determination of the validity of the claim will be made by the ALDOT.

If the Contractor decides to rescind the notice of intent and voluntarily waive any claim for additional compensation, he shall notify the Construction Bureau in writing, with copy to the Project Manager.

The Contractor hereby agrees to rescind the notice of intent and waive any claim for additional compensation if he accepts any alternate resolution outside the claims process, in whole or in part, such as a time extension or supplemental agreement. A copy of said alternate resolution should be sent to the Construction Bureau to formally close the claim file.

110.03 Record Keeping.

After giving the ALDOT a notice of intent to file a claim, the Contractor shall keep daily records of all costs incurred for affected operations. These daily records shall identify each operation affected, quantities of any additional work performed, the specific locations where work is affected, and the potential effect to the project's schedule such as days of delay or changes in production rates. Additionally, these records shall include details of all labor, material, and equipment applicable to affected operations. On Monday, or the first work day, of each week following the date of the notice of intent to file a claim, the Contractor shall provide the ALDOT's Project Manager with the daily records for the preceding week. The ALDOT's Project Manager will also keep separate records for the purpose of verifying the Contractor's records. If the Contractor's records indicate costs greater than those kept by the ALDOT, the ALDOT will notify the Contractor of any discrepancies. The Contractor shall have the opportunity to provide additional documentation regarding said discrepancies

Refusal or failure by the Contractor to present his records shall constitute a waiver by the Contractor of his claim.

To protect the integrity of the independent records maintained by ALDOT for comparison with those submitted by the Contractor, ALDOT records will not be made available to the Contractor until after ALDOT'S receipt of the Contractor's complete records documenting the claim. ALDOT will retain possession of the records and provide copying facilities with the Contractor reimbursing the ALDOT for the expense of the copying. No amendment to the claim shall be made following receipt of the ALDOT's records.

110.04 Claims Process.

(a) General.

After the work has been completed on the disputed item(s) of work and/or the period of delay or impact has concluded, the Project Manager will affirm in writing to the Construction Bureau, with copy to the Contractor, the end date of the claim period. The Contractor shall have 90 calendar days from the claim end date to submit his claim documentation to the Construction Bureau. Any claim not submitted within this 90 calendar day period is waived. The Contractor shall submit either an electronic copy of the claim to the Construction Bureau, with copy to the Project Manager, or seven hard copies (one of which shall be unbound for duplication purposes) to the Construction Bureau and two hard copies to the Project Manager. The claim shall contain the required daily records listed in Article 110.03 plus any applicable supporting documentation in accordance with Subarticle 109.04(b). Once the claim is received the Area will submit to the Construction Bureau a copy of their records and recommendation regarding the Contractor's claim. The review of the claim will be made by the Construction Bureau and a written response or request for additional information will be sent to the Contractor within 90 calendar days. If the Contractor does not agree with the claim review, he may send a written request to make a presentation to the Claims Committee by certified mail to the Construction Bureau within 30 calendar days from the date of the ALDOT's claim review. Failure to make the request within the required time period shall constitute the Contractor's acceptance of the claim review and waiver of the right to a review by the Claims Committee.

(b) Claims Committee.

The Claims Committee will be composed of five ALDOT employees whose position is that of an assistant bureau chief or higher, and who were not involved in the design or construction of the project. For Federal Aid projects, the FHWA will be invited to send an observer. The ALDOT will notify the Contractor in writing of the date and location of the presentation. The Contractor may make request to the Construction Bureau to reschedule the presentation. Said request must be received at least one week prior to the scheduled date. If the claim was submitted on behalf of a Subcontractor, both the Contractor and the Subcontractor must have a representative in attendance at the presentation. Issues not specifically presented in the claim package acted upon by the Construction Bureau and the Area are not subject to consideration by the Claims Committee. Following the presentation, the Claims Committee will provide a written recommendation to the Director. The Claims Committee's recommendation may be accepted, modified or denied by the Director. If accepted, the Director's decision shall be final, non-appealable, and not subject to judicial or other review except as provided in these Specifications.

If the Contractor does not accept the decision of the Director, he may send a written request to make a presentation to the Claims Appeal Board. This request shall be made in accordance with Item 110.04(c)2. below. Failure to make the request within the required time period shall constitute the Contractor's acceptance of the Director's decision and waiver of the right to a review by the Claims Appeal Board.

(c) Claims Appeal Board.

1. Composition and Appointment.

The Claims Appeal Board is a standing committee created to receive a presentation regarding a claim. The Claims Appeal Board will hear claims for additional monetary compensation which may include a request for a time extension; however, stand-alone time extension requests will not be considered by the Board. The Board consists of three primary members who are normally appointed for two-year terms. A three-member pool of alternates will be selected from which to provide a substitute for the primary member in the event that the primary member is unable to serve at a particular time or in the event that the Director declares the position vacant due to unfitness, death, illness, incapacity, conflict of interest or any other circumstance which would make service on the

Board by that member impossible, difficult or unobjective. The three primary members of the Board and three alternates are appointed in the following manner. The Transportation Director appoints the primary and one alternate for one position. The Alabama Road Builders' Association appoints the primary and one alternate for a second position. The Transportation Director and the Alabama Road Builders' Association jointly appoint the primary and one alternate for a third position. The jointly appointed primary member will be the Board Chairman. The jointly appointed alternate will be the alternate Board Chairman. At least one Board Member must be a licensed Professional Engineer in the State of Alabama.

In the event that an alternate member is elevated to permanently replace a primary member of the Board, then a new alternate shall be appointed in the same manner as was the departing alternate. Such will also be the case if an alternate position is declared vacant by the Director due to death, illness, incompetence or other reasons. In the event that both the primary member and the alternate member are unable to serve or must recuse themselves due to conflict of interest, etc., on a particular claim(s) hearing, a new member of the Board will be appointed in the same manner as the primary member to sit for that particular hearing.

The ALDOT will notify the Contractor in writing of the date of the presentation and the names of the Board members. The Contractor will have ten calendar days from receipt of the letter to file with the Director, by certified mail, an objection as to the composition of the Board which specifically details the nature of the objection. The Director shall have final authority in determining the composition of the Board.

Each Board member will be paid $60 per hour for actual time spent on reviewing the plans, specifications, and claim; attending the presentation and for preparing the report to the Director. This payment will cover all compensation and expenses.

2. Presentations.

The Contractor may initiate a request for a Board presentation by submission of a written notice by certified mail to the Director within 30 calendar days from the date of the Director’s decision on the recommendation of the Claims Committee. Failure to make the request within the required time period shall constitute waiver of the claim by the Contractor. The Board presentation will convene at the mutual convenience of the Board, the Department, and the Contractor. Issues not specifically presented in the original claims package are waived and are not subject to consideration by the Board. The Contractor shall not contact or have any discussions with members of the Claims Appeal Board while the claim is pending except during the formal presentation.

The FHWA will be invited to send an observer for Federal Aid projects.

The Contractor shall pay for 50 percent of the expenses of a Board presentation. The written recommendation of the Board will be sent to the Director following the presentation. The Claims Appeal Board's recommendation may be accepted, modified, or denied by the Director. After receiving the recommendation of the Claims Appeal Board, the Director has 45 calendar days to report his decision to the Contractor.

The Director's decision in the resolution of any and all claims shall be final, non-appealable and not subject to judicial or other review. The decision of the Director is binding upon all parties including, but not limited to, contractors, subcontractors, and third party beneficiaries. After the final ruling by the Director on a claim, a supplemental agreement shall be processed to make payment for any amount deemed payable by the Director.

110.05 Claim Compensation.

(a) General.

1. Compensable Items.

The liability of the Department for claims will be limited to the following specifically identified compensable items which shall be evaluated per Article 109.04:

a. Additional job site labor expenses, plus workmen’s compensation insurance.
b. Additional costs for materials.
c. Additional job-site overhead.
d. Equipment costs.
e. Professional services.
f. Bond costs.
g. Subcontractor costs as determined by, and limited to, those items identified as payable under Subitems a, b, c, d, e, and f above.

h. Administrative allowance, to the Prime Contractor for processing a claim on behalf of a subcontractor.
i. Gross receipts tax.
j. Public liability and property damage insurance.
k. Interest that accrues after 30 calendar days from the date of the Governor's signature on the supplemental agreement that makes payment for a claim.

2. Non-Compensable Items.

The Department will have no liability for the following specifically identified non-compensable items:

a. Profit, in excess of that provided in Article 109.04.
b. Loss of anticipated profit.
c. Labor and equipment inefficiencies.
d. Home office overhead in excess of that provided in Article 109.04.
e. Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities and insolvency.
f. Indirect costs or expenses of any nature.
g. Attorneys fees, claims preparation expenses or costs of litigation.
h. Interest prior to the final resolution of the claim as defined in Subitem 110.05(a)1.k. above.

(b) Claims for Delay.

The Department will have no liability for damages due to delay, beyond those items which are specifically identified as compensable under Subarticle 110.05(a) above. Equipment costs, for equipment involved in a delay claim, shall be determined in accordance with the requirements for Standby Rates as provided in Item 109.04(b)4.

The Department will be liable only for those delay damages caused by or arising from acts or omissions on the part of the Department which violate legal or contractual duties owed to the Contractor by the Department. Such delays may constitute a basis for a claim for delay damages and/or a request for a time extension. The Contractor assumes the risk of damages from all other causes of delay.

(c) Claims for Acceleration.

The Department will have no liability for any constructive acceleration unless the Department gives express written direction for the Contractor to accelerate his effort beyond that required by the original contract. Any acceleration related costs will be handled as extra work as provided in Article 104.03.

110.06 Required Claim Documentation.

All claims shall be submitted in writing and shall be sufficient in detail to enable the Engineer to ascertain the basis and the amount of each claim as set forth in Article 110.03, Subarticle 110.04(a), and Subarticle 109.04(b). All information submitted to the Department under this Article will be used solely for analyzing and/or resolving the claim. Additionally, the following information shall be provided for all claims:

(a) A copy of the "Written Notice of Intent to File a Claim" submitted for the specific claim by the Contractor, and by the Subcontractor if applicable.
(b) The date on which actions resulting in the claim occurred or conditions resulting in the claim became evident.
(c) A detailed factual statement of the claim providing all necessary dates, locations and items of work affected by the claim.
(d) The specific provisions of the Contract which support the claim, and a statement of the reasons why such provisions support the claim.
(e) The amount of additional compensation sought and a break-down of the amount into the categories specified as payable under Article 110.05, Claim Compensation.
(f) The name, function, and activity of each Department official, or employee, involved in, or knowledgeable about facts that give rise to such claim.
(g) The name, function, and activity of each Contractor or Subcontractor official, or employee, involved in, or knowledgeable about facts that give rise to such claim.
(h) The identification of any pertinent documents, and the substance of any material oral communication relating to such claim.

(i) If an extension of time is also sought, the specific days for which it is sought and the basis for such request.

For delay claims, in addition to the above, a description of the operations that were delayed, the reasons for the delay and how they were delayed will be required.

110.07 Auditing Of Claims.

All claims filed against the Department shall be subject to audit by the Department's External Auditor at any time following the filing of such claim. The audit may begin on ten days notice to the Contractor, Subcontractor, or Supplier. The Contractor, Subcontractor, or Supplier shall cooperate with the auditors. Failure of the Contractor, Subcontractor, or Supplier to maintain and retain sufficient records to allow the Department's auditor to verify the claim shall constitute a waiver of that portion of such claim that cannot be verified and shall bar recovery thereunder.

Without limiting the generality of the foregoing, and as a minimum, the auditors shall have available to them the following documents:

(a) Daily time sheets and foreman's daily reports.
(b) Union agreements, if any.
(c) Insurance, welfare, and benefits records.
(d) Payroll register.
(e) Earnings records.
(f) Payroll tax returns.
(g) Material invoices, purchase orders, and all material and supply acquisition contracts.
(h) Material cost distribution worksheet.
(i) Equipment records (list of company equipment, rates, etc.).
(j) Vendor rental agreements, and Subcontractor invoices.
(k) Subcontractor payment certificates.
(l) Canceled checks (payroll and vendors).
(m) Job cost report.
(n) Job payroll ledger.
(o) General ledger, general journal, (if used) and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals.
(p) Cash disbursements journal.
(q) Financial statements for all years reflecting the operations on this project.
(r) Income tax returns for all years reflecting the operations on this project.
(s) Depreciation records on all company equipment whether such records are maintained by the company involved, its accountant, or others.
(t) If a source other than depreciation records is used to develop costs for the Contractor's internal purposes in establishing the actual cost of owning and operating equipment, all such other source documents.
(u) All documents which reflect the Contractor's actual profit and overhead during the years this Project was being performed and for each of the five years prior to the commencement of this Project.
(v) All documents related to the preparation of the Contractor's bid including the final calculations on which the bid was based.
(w) All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim.
(x) Worksheets used to prepare the claim establishing the cost components for items of the claim including, but not limited to, labor, benefits and insurance, materials, equipment, subcontractors, and all documents which establish the time periods, individuals involved, the hours and the rates for the individuals.

SECTION 111
DISADVANTAGED BUSINESS ENTERPRISE (DBE)

111.01 Goals.

This contract contains a specific goal for the participation of certified DBEs. The goal is expressed as the percentage of the total amount of the contract that is required for DBE participation and is given in the proposal. This type of participation is defined as Race Conscious.

If no specific percentage is indicated in the proposal, then any DBE firm utilized for work in this contract is defined as Race Neutral. The requirements listed in Article 111.08 and 111.09 still apply to contracts with no specific goal. In addition, any participation by DBEs above the required goal is also defined as Race Neutral.

111.02 Certification.

The Department maintains a current listing of certified DBE firms by categories of work. The Department's certification extends only to the requirements of 49 CFR 26 with regard to business size, disadvantaged status, and ownership and control of business. The certification does not attest in any way to the capabilities or capacity of any business to perform satisfactorily.

DBE firms that are not on the current certification list must seek approval prior to tendering an offer on any project. Any work performed on a contract or subcontract that was executed prior to a firm obtaining DBE certification is not eligible to be counted as participation towards the goal.

111.03 Submittal of DBE Utilization Plan.

This contract will be awarded to the lowest responsible bidder. All bidders must submit within five calendar days of the letting date the following information in writing on Form OE-110 (DBE Utilization Plan) provided by the Department:

- The name, certification number, and address of the DBE firm or firms;
- Identify the type of firm as a contractor (including haulers), supplier, or manufacturer;
- The pay item(s) and description of the work to be subcontracted, including the quantities, subcontract unit prices, and the unit of measurement for compensation;
- If said unit of measurement for compensation differs from that of the pay item, indicate the percentage of the overall pay item quantity to which the subcontract applies;
- The total dollar amount of the work to be subcontracted to the DBE firm (this amount shall not include Bonds or Gross Receipts Tax);
- A written commitment from the bidder to use the DBE;
- A written confirmation from the DBE that it is participating in the contract as provided in the commitment.

Each DBE should only be listed on one line. Additional sheets detailing the required information , such as quotes received, may be attached as needed.

111.04 Failure by Low Bidder or Contractor to Meet DBE Goal.

In the event the apparent low bidder cannot meet the DBE goal for submission of his DBE Utilization Plan, or the Contractor does not meet the DBE goal based on actual participation during construction, he must provide documentation that good faith efforts were made to meet the goal in accordance with Article 111.05, including seeking replacement DBE participation when a DBE is terminated or fails to perform.

111.05 Good Faith Efforts.

(a) Solicitation of DBE Participation.

A good faith effort is soliciting through all reasonable and available means (e.g., attendance at pre-bid meetings, advertising, written notices, corresponding with the ALDOT's DBE Program Coordinator, placing postings on the Small Business Network of Bid Express) the interest of all certified DBEs who have the capability to perform the work of the contract. The bidder must solicit this interest within sufficient time to allow the DBEs to respond to the solicitation. The bidder must determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.

(b) Selecting Portions of the Contract Work to Facilitate DBE Participation.

A good faith effort is selecting portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goals will be achieved. This includes, where appropriate, breaking out contract work items in to economically feasible units to facilitate DBE participation, even when the bidder might otherwise prefer to perform these work items with its own forces.

(c) Providing Information About Contract Requirements.

A good faith effort is providing interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

(d) Negotiating in Good Faith.

A good faith effort is negotiating in good faith with interested DBEs. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBEs to perform the work.

A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a bidder to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Bidders are not, however, required to accept higher quotes from DBEs if the price difference is excessive or unreasonable.

(e) Investigating the Capabilities of a DBE to Perform the Work.

A good faith effort is establishing sound reasons (based on a thorough investigation of the capabilities of a DBE to perform the work) for rejecting a DBE as being unqualified. The bidder's standing within its industry, and membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. nonunion employee status) are not legitimate causes for the rejection or nonsolicitation of bids in the bidder's efforts to meet the project goal.

(f) Providing Assistance in Obtaining Bonding, Credit, and Insurance.

A good faith effort is providing assistance to interested DBEs in obtaining bonding, lines of credit, or insurance as required by the DBE or bidder.

(g) Providing Assistance in Obtaining Equipment, Supplies, and Materials.

A good faith effort is providing assistance to interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

(h) Utilizing Industry, Governmental, and Service Groups.

A good faith effort is effectively using the services of available minority/women contractors' groups; local, State, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs.

111.06 Evaluation of Good Faith Efforts.

The Department has established a "Good Faith Efforts Committee" to review the documentation submitted by the Contractor to determine if there were any DBE violations as outlined in Article 111.09.

If the Good Faith Efforts Committee determines the information and documentation from the bidder are satisfactory, the bid will be declared responsible. Acceptable good faith efforts may include activities in addition to those that are described in Article 111.05 and 49 CFR Part 26 Appendix A. A low bidder's good faith efforts on other ALDOT construction contracts may be considered in determining the acceptability of the low bidder's good faith efforts to meet current participation goals.

If the information and documentation are unsatisfactory, the bidder will be notified in writing within five days. The bidder will be given the opportunity to appear before the Department's Transportation Director to present additional evidence of good faith efforts. The bidder will then be given a written decision on the outcome of the consideration of this evidence.

Failure to meet the contract goal or demonstrate good faith efforts will result in the bid being declared to be in default and the bid bond shall be forfeited.

111.07 DBE Termination After Award of the Contract.

(a) Notification of Termination.

A prime contractor cannot terminate a DBE subcontractor listed on the DBE Utilization Plan for convenience and then perform the work of the terminated subcontract with its own forces or those of an affiliate, without prior written consent from the Construction Bureau. If a listed DBE subcontractor fails to perform, or performs unsatisfactorily, the prime contractor will notify the Project Manager in writing, with a copy to the Construction Engineer, stating the reasons for termination with supporting documentation.

(b) Substitution of New DBE for Terminated DBE.

If the reasons for termination are satisfactory, the prime contractor will be required to obtain a substitute DBE and submit a revised DBE Utilization Plan for review and approval by the Construction Bureau, or demonstrate good faith efforts as described in Articles 111.05 and 111.06 in trying to obtain a substitute DBE. If the prime contractor fails or refuses to comply, the Department reserves the right to issue a warning letter as defined in the DBE Violations (Article 111.09) and/or an order stopping all or part of the payment and work until satisfactory action has been taken.

111.08 Credit for Work Assigned to Meet the DBE Goal.

(a) Value of Work Performed by a DBE.

1. Work Done Directly by DBE Forces.

The dollar amount of that portion of a construction contract that is performed by the DBE's own forces will be counted towards meeting the DBE goal. This dollar amount shall include the cost of supplies and materials obtained by the DBE for the work of the contract, including equipment leased by the DBE. This dollar amount shall not include supplies, materials, and equipment the DBE purchases or leases from the prime contractor or affiliates of the prime contractor. (The term "affiliates" is defined in Subarticle 102.02(a)).

2. Fees and Commissions Charged by a DBE.

The dollar amount of fees or commissions charged by a DBE firm for providing a service, such as professional, technical, consultant, or managerial service, or for providing bonds or insurance specifically required for the performance of the contract will be counted towards meeting the DBE goal. The fee shall be reasonable and not excessive as compared with fees customarily paid for similar services.

3. DBE Obtaining a Subcontract with Lower Tier Subcontractor.

When a DBE subcontracts part of the work of its subcontract to another firm, the value of this work will be counted toward the DBE goal if the DBE's subcontractor is a DBE.

Work that a DBE subcontracts to a non-DBE firm will not be counted toward the DBE goal.

(b) Joint Venture.

When a DBE performs as a participant in a joint venture, the dollar amount of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE performs with its own forces will be counted toward DBE goal.

(c) Commercially Useful Function.

1. Requirement for a Commercially Useful Function.

The dollar amount of contract work performed by a DBE will only count towards meeting the DBE goal if the DBE performs a "commercially useful function".

2. Definition of a Commercially Useful Function.

A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. The determination of whether or not a DBE is performing a commercially useful function will be based on the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing, and the DBE credit claimed for its performance of the work, and other relevant factors.

3. Extra Participation (Not a Commercially Useful Function).

A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of DBE participation. The determination of whether or not a DBE is an extra participant will be based on similar transactions, particularly those in which DBEs do not participate.

4. Insufficient Participation (Not a Commercially Useful Function).

If a DBE does not perform or exercise responsibility for at least 30 % of the total cost of its contract with its own work force, or the DBE subcontracts a greater portion of the work than would be expected on the basis of normal industry practice for the type of work involved, the DBE is not performing a commercially useful function.

5. Consideration of Trucking as a Commercially Useful Function.

The following factors will be given consideration in determining whether or not a DBE trucking company is performing a commercially useful function:

a. Responsibility for Management and Supervision of Trucking.

The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.

b. Truck Ownership and Operation.

The DBE must own and operate at least one fully licensed, insured, and operational truck used on the contract.

c. Credit for Transportation Services.

The DBE will receive credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.

d. Leasing from DBE Firm.

The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE will receive credit for the total value of the transportation services the lessee DBE provides on the contract.

e. Leasing from Non-DBE Firm.

The DBE may also lease trucks from a non-DBE firm, including an owner-operator. The DBE who leases trucks from a non-DBE is entitled to credit only for the fee or commission it receives as a result of the lease arrangement. The DBE does not receive credit for the total value of the transportation services provided by the lessee, since these services are not provided by a DBE.

f. Exclusive Use of Truck During Lease.

To receive credit for trucking, it must be clearly shown on a lease that the DBE has exclusive use of, and control over the truck. This does not preclude the leased truck from being used for work for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

g. Lease Agreement Documentation

A copy of each lease agreement, both for DBE firms and non-DBE firms, must be submitted with the DBE Utilization Plan if the DBE Trucking company intends on utilizing a this type of trucking participation or with the first Form DBE-10 submittal after the lease agreement is executed and utilized on the contract.

6. Consideration of Appeal by DBE that Work is a Commercially Useful Function.

When it is determined that a DBE is not performing a commercially useful function the prime contractor and the DBE will be given the opportunity to provide documentation to rebut this determination.

The Department's decisions concerning commercially useful functions are subject to review by other entities but are not administratively appealable to the USDOT.

(d) Materials and Supplies Counted Toward Meeting the DBE Goal.

1. DBE Manufacturer.

If the materials or supplies are obtained from a DBE manufacturer, 100 % of the cost of the materials or supplies will be counted toward meeting the DBE goal.

A DBE manufacturer shall be defined as a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract.

2. DBE Regular Dealer.

If the materials or supplies are purchased from a DBE regular dealer, 60 % of the cost of the materials or supplies will be counted toward meeting the DBE goal.

A DBE regular dealer shall be defined as a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business.

To be a DBE regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.

A person may be a DBE regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business if the person both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment shall be by a long-term lease agreement and not on an ad hoc or contract-by-contract basis. In addition, the regular dealer, with the exception of steel, must be certified in accordance with the Department’s program for the Materials, Sources and Devices with Special Acceptance Requirements Manual.

Packagers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not DBE regular dealers.

3. Brokers

With respect to materials or supplies purchased from a DBE which is neither a DBE manufacturer nor a DBE regular dealer, the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site, will count toward the DBE goal if the fees are reasonable and not excessive as compared with fees customarily allowed for similar services.

The cost of the materials and supplies will not be counted toward the DBE goal.

(e) Certification at the Time of the Execution of the Contract.

If a firm is not currently certified as a DBE at the time of the execution of the contract, the firm's participation in the contract will not be counted toward the DBE goal.

When a prime contractor has made a commitment to using an ineligible firm (one decertified by the Department) and a subcontract has not been executed before the Department issued the decertification notice, work by the ineligible firm does not count toward the contract goal. The prime contractor must meet the contract DBE goal with an eligible DBE firm or demonstrate that he has made good faith efforts to do so.

If a prime contractor has executed a subcontract with an ineligible firm before the Department issued the decertification notice, the prime contractor may continue to use the firm on the contract and may continue to count the firm’s participation toward the contract DBE goal.

If a prime contractor executes an additional subcontract to a firm that is certified at the time of execution, the firm’s participation associated with the additional subcontract will be counted towards the contract DBE goal.

(f) Payments Considered Applicable to the DBE Goal.

The participation of a DBE subcontractor toward meeting the DBE goal will only be counted toward the goal after the compensation for the work has been has been paid to the DBE.

(g) Reporting DBE Performance.

1. Monthly Estimate Report.

To document the DBE participation for the contract, the prime contractor shall furnish the Project Manager an ALDOT FORM DBE-10 for each estimate period. In the case of contracts with more than one project, a Form DBE-10 shall be submitted for each project estimate. The prime contractor shall provide the required data for each DBE active on the project during the estimate period, including those not listed on the DBE Utilization Plan. The participation amounts reported shall not include bond or gross receipts tax. If no DBE was active during the time period, such indication should be made on the form.

Form DBE-10 shall be submitted on all Federal aid projects regardless of whether or not the contract contains a specific DBE goal.

The Form DBE-10 shall be submitted within sixty calendar days of the close of the estimate period for which it applies. Failure to furnish the Form DBE-10 in a timely manner may result in the withholding of further monthly estimates until the delinquent information has been submitted.

2. Monthly Estimate Documentation.

For DBE Manufacturers, Dealers, and Broker (including any fee/commission service work), a copy of the paid invoice shall be submitted with the DBE-10 form work for which the work performed and services provided applies. For DBE Truckers who haul materials from a commercial facility such as a quarry to the plant for stocking purposes for the production of materials for the contract, a copy of each haul ticket shall be provided to the Project Manager with the DBE-10 form. This documentation is to verify the work performed for this contract.

3. Final Report.

Prior to the submission of the final estimate voucher for signing, the prime contractor shall furnish a final Form DBE-10 for each DBE subcontractor. This final Form DBE-10 shall be submitted to document any changes in the quantities of work performed by the DBE since the project completion due to the final quantities review and resulting payment adjustments. This form shall be submitted with the information required in Subarticle 109.12(c).

4. Certification of Actual Payments Form.

Prior to the submission of the final estimate voucher for signing, the prime contractor shall furnish a Certification of Actual Payments to DBE Firms (Form DBE-11) for each DBE subcontractor. This form shall be submitted with the signature of an authorized representative of the DBE in order to document the total amount paid to the DBE firm as indicated on the final Form DBE-10. In the event that the DBE firm has gone out of business and is unavailable to sign the form, the prime contractor shall submit copies of the subcontractor estimates and cancelled checks verifying the amount paid to the DBE firm. If the total amount paid to the DBE firm includes bond and/or gross receipts tax, the eligible DBE participation total without these amounts shall also be indicated. This form shall be submitted with the information required in Subarticle 109.12(c).

111.09 DBE Violations.

(a) Descriptions of Violations.

1. Violations by Bidders and Prime Contractors.

Possible violations by bidders and prime contractors include, but are not limited to, failure to provide the DBE Utilization Plan within five calendar days of the letting date, failure to meet the contract goal, failure to make good faith efforts, deleting DBE subcontractors for convenience, improper DBE participation credit reports, continued failure to furnish Form DBE-10 reports, failure to comply with Department decisions and directives concerning DBE activities, and fraud.

2. Violations by DBE Subcontractors.

Possible violations by DBE subcontractors include those listed in 49 CFR Part 26.107 as well as failure to fulfill contract commitments and negotiations.

3. Determination of Violations.

These violations are only possible examples and not all inclusive. The Department reserves the right to determine exact violations and the extent of each violation on a case-by-case basis.

(b) Violations Prior to Award of the Contract.

Failure by the apparent low bidder to provide the DBE Utilization Plan within the time frame specified will result in the bid being considered irregular in accordance with Subarticle 102.07(a), and the bid will be rejected. If the apparent low bidder does provide the DBE Utilization Plan within the time frame specified, but fails to make and document good faith efforts, the contract will not be awarded to that bidder and will result in the forfeiture of its bid bond.

The next low bidder will become the new low bidder. Failure to have provided the DBE Utilization Plan within the time frame specified will result in the bid being considered irregular in accordance with Subarticle 102.07(a), and the bid will be rejected. If this bidder does provide the DBE Utilization Plan within the time frame specified, but fails to make and document good faith efforts, the contract will not be awarded to that bidder and will result in the forfeiture of its bid bond.

If the contract is awarded to the next low bidder, the original low bidder will be prohibited from doing any work relating to the contract either as subcontractor or in any other capacity.

These restrictions shall apply to any other name under which the same person, individual, partnership, company, firm, corporation, association, cooperative, affiliate, or other legal entity may be operating, and in which the principal owner(s) are involved.

(c) Violations While the Contract is in Effect.

For the first violation of the DBE requirements, a letter will be written to the prime contractor and/or the DBE, if applicable, citing the violation and warning that failure to rectify the violation or further violations will result in disqualification as outlined in Subarticle 102.02(b).

The second violation will result in the prime contractor and/or the DBE subcontractor being disqualified as outlined in Subarticle 102.02(b) for an indefinite period. The disqualification may be reviewed each six months, if requested in writing by the disqualified firm.

The third violation will result in the prime contractor and/or the DBE subcontractor being disqualified as outlined in Subarticle 102.02(b) for an indefinite period. The disqualification will be for at least one year. It may be reviewed after one year, if requested in writing by the disqualified firm.

An exception to the above is that an open and flagrant violation. The prime contractor and/or the DBE subcontractor will not be issued a warning letter, and the prime contractor and/or DBE subcontractor will be summarily disqualified as outlined in Subarticle 102.02(b) for at least six months. The disqualification may be reviewed after such time, if requested in writing by the disqualified firm. If applicable, the DBE subcontractor's continued status as a certified DBE will be recommended to the Department's DBE Review Committee for review.

DIVISION 200
EARTHWORK

SECTION 201
CLEARING AND GRUBBING

201.01 Description.

Clearing and grubbing shall be the removal and disposal of vegetation (trees, shrubs, vines, stumps, roots, etc.) and other objects (trash, refuse, debris, etc.) within designated limits.

201.02 Materials.

Herbicides allowed for use shall be approved by the Department. Only herbicides listed in the ALDOT "Manual for Roadside Vegetation Management" shall be used.

201.03 Construction Requirements.

(a) Control of Erosion and Stormwater Runoff.

The requirements for the control of erosion and stormwater runoff are given in Article 107.21 and Section 665. These requirements shall be implemented prior to the beginning of initial clearing operations.

(b) Work Limits.

The Engineer will designate the location and extent of right of way lines, easement lines and construction limits. Work limits may be designated by the Engineer within right of way lines, easement lines, and construction limits when limited work is required.

The Contractor shall not exceed the maximum limit established for the exposure of erodible material.

(c) Vegetation Designated to Remain Undisturbed.

The Contractor shall not damage vegetation and terrain that the Engineer designates to remain undisturbed. Damage shall be repaired without additional compensation as directed by the Engineer.

(d) Disposal of Materials.

The Contractor shall dispose of all removed materials. The Contractor shall comply with all local, State and Federal laws and ordinances pertaining to disposal.

The Contractor shall submit a plan for the satisfactory disposal of materials. Clearing shall not begin until the Engineer accepts the plan as having sufficient detail. The plan shall include an acceptable means for the treatment of disposal areas so as not to present an unsightly appearance, create a public nuisance or create future maintenance problems for the Department.

The disposal plan shall provide for the satisfactory disposal of biodegradable materials and rubbish within 30 days after accumulation, unless a longer period is authorized in writing by the Engineer, to prevent the infestation of pests.

Disposal by the burning of perishable materials will be permitted only when authorized in accordance with the requirements given in Articles 107.13 and 107.22. Burning will not be allowed on the State right of way unless approved in writing by the Engineer.

Disposal by the indiscriminate dumping of materials, with or without the property owner's consent, is not satisfactory disposal. The Contractor shall obtain written permission from the property owner for any disposal area. A copy of the written permission from the property owner shall be submitted to the Engineer prior to disposal.

The use of mechanical brush clippers or other recycling methods may be considered for approval.

(e) Clearing and Grubbing (Pay Item 201-A).

1. Clearing.

Clearing shall be the removal of vegetation on and above the ground surface within the construction limits.

Clearing shall also be the selective removal (removal designated by the Engineer) of vegetation beyond the construction limits to the limits of the right of way or easement lines.

Trash, refuse and debris shall be removed with the removal of vegetation.

2. Grubbing.

The areas within the limits of construction shall be grubbed as directed by the Engineer and as follows.

- Grubbing within fill areas shall be the complete removal, regardless of depth in the ground, of vegetation and other objects where any part of the vegetation or object is within 1 foot {300 mm} of the ground surface.
- Grubbing outside of actual foundation excavation lines at bridge sites and channel changes shall be limited as directed by the Engineer so that stumps may be left in place to aid in erosion control.
- Grubbing in all other areas within the construction limits shall be the complete removal of vegetation and other objects where any part of the vegetation or object is visible at the ground surface.

3. Clearing and Grubbing at Bridge Construction Sites.

When a pay item is not given on the plans for the clearing and grubbing at bridge construction sites, the Contractor shall clear and grub the entire width of the right of way without extra compensation. Clearing and grubbing shall begin 1 foot {300 mm} before the beginning of any part of a structure (usually the structure wings, end bents or abutments) and shall end 1 foot {300 mm} beyond the end of any part of the structure.

(f) Selective Clearing (Pay Item 201-B).

Selective Clearing shall comply with the requirements shown on the plans and shall be performed as directed by the Engineer.

(g) Clearing (Pay Item 201-C).

1. Required Clearing.

The work of clearing is usually required for the removal of trees, bushes, trash and refuse along the right of way where earthwork will not be required.

Clearing shall be the removal of trees and bushes and possibly the chipping of timber and the spreading of the chips. Any areas where chipping and spreading are allowed or required will be shown on the plans. Clearing shall also be the removal and disposal of trash, refuse and debris.

2. Damage Caused By Removal Operations.

Off-road equipment shall not travel on, be parked on, or operate on the wearing surface of the roadway. The Contractor shall perform the work as directed by the Engineer to minimize the damage done to the existing terrain. Damage to the paved or grassed shoulders shall be repaired by the Contractor without extra compensation. When conditions exist where deep rutting or other grade disturbances are caused by the operation of machinery, work shall cease or alternate methods shall be chosen to complete the work. Any damaged areas shall be repaired at the contractor's expense.

3. Cutting Down Trees.

Where trees cannot be felled without endangering traffic, encroachment on the roadway, injury to other trees, structures, or property, they shall be cut down in sections.

4. Mowing.

Areas that have cross-sectional slopes of 2:1 or flatter shall be mowed to a height of 6 inches {150 mm}(max.) with a rotary type cutter in one continuous operation after trees and underbrush have been removed. Mowing shall be completed prior to the final acceptance of the project.

5. Areas Where the Chipping of Timber and Spreading of Chips Are Required.

Areas where the chipping of timber and spreading the chips is allowed or required will be shown on the plans. Tree trunks, limbs and bushes shall be cut into chips using a chipping machine. The average largest dimension of a chip shall not be greater than 4 inches {100 mm}. The chips shall be loosely dispersed to eliminate any accumulation of a continuous blanket layer. The Contractor shall chip any debris created by the clearing operation and any pre-existing debris, such as dead trees and limbs, to leave the area suitable for mowing.

6. Removal By the End of the Workday.

Tree trunks and limbs 4 inches {100 mm} or greater in diameter shall be removed from the project site, or chipped if required, by the end of the workday on which they are cut.

7. Removal of Stumps.

Stumps shall be removed to the groundline or below. Removal shall be accomplished by cutting or grinding. Additionally, hardwood tree stumps shall be removed to a minimum depth of 1 foot {300 mm} below the ground line or treated with an ALDOT approved dyed herbicide designated for cut stump treatment immediately after cutting or grinding.

201.04 Method of Measurement.

(a) General.

For Pay Item 201-A, the area to be cleared and grubbed will include the entire area within the construction limits, right of way lines and easement lines and will be measured as one lump sum unit. An approximate number of acres {hectares} will be given in the pay item description. There will be no measurement of the clearing and grubbing required at bridge construction sites where there is no pay item for this work shown on the plans.

For Pay Item 201-B, the roadside areas required to be selectively cleared will be measured in acres {hectares}, computed from surface measurements of the area cleared.

For Pay Item 201-C, roadside areas required to be cleared will be measured as one lump sum unit.

(b) Partial Payment (Item 201-A).

The estimated percentage of the total area cleared and grubbed each month will be multiplied by the Contractor's bid price for Item 201-A. These percentage payments will be made each month work is performed on this item until the entire project has been cleared and grubbed.

201.05 Basis of Payment.

(a) Unit Price Coverage.

For Item 201-A, clearing and grubbing will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete and maintain the work until acceptance of the project. Where the limits of construction are shown on the plans to extend beyond the beginning or end of the project, payment for the clearing and grubbing of these areas shall be included in the contract price.

If the location of the limits of construction, right of way lines, or easement lines result in changes in areas from those shown on the plans, payment will be handled as Extra Work as defined in Article 104.03.

For Item 201-B, selective clearing will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to complete and maintain the work until acceptance of the project.

For Item 201-C, clearing will be paid for at the contract unit price which shall be full compensation for cutting, removal of debris, chipping, spreading of chips, bushhogging, herbicide, repairing of damage to the existing ground surface (including blading, topsoil, seeding, etc.), and for furnishing all materials, equipment, tools, labor and incidentals necessary to complete and maintain the work until acceptance of the project.

(b) Payment will be Made Under Item No.:

201-A Clearing & Grubbing (maximum allowable bid $_____ per acre {hectare}) (Approximately _____ acres {hectares}) - per lump sum

201-B Selective Clearing - per acre {hectare}

201-C Clearing - per lump sum

SECTION 204
CLOSING WATER WELLS

204.01 Description.

This Section shall cover the work of closing water wells at the locations shown on the plans or directed, all in conformance with plan details, these specifications, and as approved by the Engineer.

204.02 Materials.

All materials shall conform to the requirements set forth in Division 800, Materials.

204.03 Construction Requirements.

The closure of a water well shall be in accordance with the requirements of the Alabama Department of Environmental Management (ADEM).

Closing water wells may include removal and disposal of pump(s), pipe, well casing and/or other parts of the well, if required, in order to close the well. The well shall be sealed with a sealing material meeting ADEM requirements.

204.04 Method of Measurement.

The quantity of Closing Water Wells measured for payment will be the number of separate units ordered and accepted.

204.05 Basis of Payment.

(a) Unit Price Coverage.

Payment for Closing Water Well at designated locations will be made at the contract price (per each) which shall include removal and disposal of pump(s), pipe, well casing, and/or other parts of the well (if required), furnishing and placing the sealing material to seal the well, excavation and subsequent backfill incident to well closure, and furnishing all materials, tools, equipment, labor and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

204-A Closing Water Well - per each

SECTION 205
REMOVAL AND RELOCATION OF STRUCTURES

205.01 Description.

The work under this Section shall cover the disposal or the re-establishment of structures, such as buildings, dwellings, etc., as designated on the plans or in the proposal. This work shall also include all appurtenances such as out buildings, fences, walks, driveways, utility facilities, septic tanks, other man-made objects, established lawns, shrubs, and designated trees associated with the structure.

The Department assumes no responsibility for furnishing building sites for structures other than those designated for relocation by the plans and assumes no responsibility for moving permits.

205.02 Materials.

Any material necessary for the re-establishment of a relocated structure shall meet the requirements of applicable building codes and regulations. In all cases new material shall be equal to or better than the material in the original structure.

205.03 Construction Requirements.

(a) Laws, Rules, Regulations, and Ordinances.

The Contractor shall comply with all Federal, State, City and County laws, rules, regulations, and ordinances covering moving, re-establishing, demolition or disposal of structures and appurtenances. Any utility service requiring disconnection or reconnection of a structure shall be done in accordance with the utility's regulations and shall meet the approval of the Utility.

(b) Removal of Structures.

1. Removal.

Removal of a structure shall be the demolition and disposal of the structure identified in the contract. It shall also be the restoration of the area of removal to a stable uniformly graded ground surface. At least ten workdays prior to removal of any structure the contractor must file ADEM Form 496 with the appropriate regulatory authority as designated by the form instructions.

2. Asbestos.

a. Examination of Structure for Asbestos before Structure Removal.

The Contractor shall determine if asbestos is present in or on a structure before it is removed. The structure shall be examined for the presence of asbestos in accordance with the rules and regulations of the governmental agencies that have regulatory jurisdiction over the work (ADEM, OSHA, ADPH, etc.). An Alabama accredited asbestos inspector must conduct a thorough inspection

of each structure and the report generated shall be submitted by the contractor to the Engineer and the above described regulatory authority. There will be no direct payment for the cost of the investigation required to determine whether or not asbestos is present in or on the structure. The determination of the presence of asbestos shall be a subsidiary obligation of Pay Item 205-A "Removal of Structures".

b. Credentials for Removal and Disposal of Asbestos.

The removal and disposal of asbestos shall be done by Contractors or Subcontractors that have accreditation credentials from the "Alabama Safe State Environmental Programs" and are certified by ADEM as Asbestos Removal Contractors.

c. Removal of Asbestos from a Structure.

If asbestos is found in a structure the Contractor shall obtain three price quotes for the cost of the removal and disposal of the asbestos. The price quotes shall be submitted to the Engineer for the selection of the Contractor or Subcontractor for the removal work. The cost of the removal work will be paid for as Extra Work in accordance with the requirements given in Article 109.04.

3. Septic Tanks.

The removal (and abandonment) of septic tanks shall be done in accordance with the requirements of the Alabama Department of Public Health (ADPH). Direct payment will not be made for pumping the contents of the tank prior to removal of the septic tank and the sand or aggregate backfill that may be required to meet regulatory requirements for backfilling abandoned septic tanks.

If the removal of septic tanks is not shown to be required on the plans, and the tanks are required to be removed by the Engineer, payment for the removal will be made as Extra Work in accordance with the requirements given in Article 109.04.

(c) Relocation of Structures.

1. General.

No structure under this classification shall be relocated until it has been inspected by the Engineer in company with the Contractor and the owners and/or lessees and its actual condition determined. An itemized written report of the condition of the structure at the time of such inspection shall be prepared by the Contractor and signed by the Engineer, Contractor, owners and/or lessees and a copy given to all parties concerned. Photographs, from negatives, not less than 4 inches {100 mm} by 5 inches {125 mm} in size shall be made of the structure as directed by the Engineer. Prints of the photographs shall be attached to and become a part of each copy of the report before the report is signed. Once a Contractor begins moving a structure, he shall vigorously and continuously prosecute its moving and re-establishment in such a manner that the owner or lessee will be inconvenienced the shortest time possible. If the work is not expedited, the Engineer may order all work stopped or withhold estimates until the work on the structure in question is satisfactorily completed.

Structures that are moved to new locations or elevations shall be set upon substantial foundations conforming to the new elevations and sites. Sound materials salvaged from the same unit may be used, supplemented by necessary new materials similar to those in the existing foundations. Any damage or injury occasioned by moving shall be repaired by the Contractor without additional compensation.

Certain structures may be designated to be cut off and re-established at the right of way line. Care shall be taken to avoid damage to the remainder of the structure and any damage thereto shall be repaired by the Contractor without additional compensation. The cutoff portion of the building outside the right of way shall be braced and refaced along the right of way line as directed, using new or suitable materials salvaged from the same unit.

The closure of a septic tank shall be done in accordance with the requirements given for "Removal of Structures".

Established shrubs and lawns, along with designated trees, are considered a part of a structure relocation, hence, they shall be either transplanted or replaced in kind. Transplanting procedures shall be consistent with details noted in these specifications for transplanting trees and shrubs and for grassing work.

2. Structure Release.

Structures and appurtenances shall not be considered satisfactorily relocated until the Contractor has furnished the Engineer with a release from the owners and lessees (if applicable) prepared on the form prescribed by the Department for the purpose. This release from the owners

and the lessees shall not preclude the Engineer from inspecting the moved structure and requiring any corrective work to be done that he considers necessary. No disposition or modification of the structure, other than that shown on the plans, will be made by any agreement between the Contractor and owner without the prior written approval of the Engineer.

If the owners or lessees of any structure refuse to execute a release for the Contractor and, if after inspection, the Engineer determines that the Contractor has done all that could be reasonably expected to be done to affect a satisfactory removal and re-establishment of the structure, the Engineer may certify such upon the Department's form, which will be sufficient to release monies due to the Contractor; however, such certification and release of monies to the Contractor will in no way be construed as a release of the liability or responsibility of the Contractor under Subarticle 107.14(a), but shall be a release only for the purpose of releasing monies to the Contractor.

(d) Disposal of Debris and Cleanup of Site after Removal and Relocation.

Disposal of debris and materials not allowed for reuse shall be done in accordance with the requirements for disposal given in Subarticle 201.03(d). After the removal of a structure has been completed the Contractor shall grade the area of removal to produce a stable uniform ground surface. When clearing and grubbing is not a part of the contract, the Contractor shall obtain approval from the Engineer to cut trees that interfere with structure removal or relocation.

If allowed by the Engineer, stone, bricks, broken concrete, concrete blocks, and concrete masonry of all types may be used to fill low areas, basements, and other depressions except abandoned septic tanks.

205.04 Method of Measurement.

The removal or relocation of structures will be measured per each structure removed or relocated.

205.05 Basis of Payment.

(a) Unit Price Coverage.

Payment will be made at the contract unit price which shall be payment in full for the removal and disposal off the right of way or the relocation and re-establishing of the structures including utilities, all appurtenances, the furnishing of any materials needed, equipment, tools, labor and incidentals necessary to complete all work required by this Section. This shall include all utility deposits, bonds, tie-in fees, etc., and other actions necessary to re-establish the structure in an operable condition. Any site grading, including basement excavation for structures, shall be considered a part of the structure unless otherwise provided by plan details.

The removal or relocation of any or all structures may be deleted from the contract at the discretion of the Engineer.

(b) Payment will be made under Item No.:

205-A Removal of Structures, Structure No. _____ - per each
205-B Relocation of Structures, Structure No. _____ - per each

SECTION 206
REMOVAL OF MISCELLANEOUS EXISTING DRAINAGE AND OTHER FACILITIES

206.01 Description.

The work under this Section shall cover the removal, wholly or in part, and the satisfactory salvaging or disposal of miscellaneous facilities and obstructions which will not be permitted to remain within the right of way except those items removed and disposed of under other sections of these specifications. Salvaging of materials for reuse by the State will be required only when such is designated by the plans or proposal; otherwise, the materials shall become the property of the Contractor.

Quantities and limits of this type work indicated on the plans are approximate only, subject to the Engineer's evaluation of the actual site condition.

206.02 Materials.

All new material required shall meet the applicable requirements of Division 800, Materials.

206.03 Construction Requirements.

Each existing bridge or portion thereof requires a removal plan to be submitted to the Construction Bureau prior to starting demolition.

The bridge removal plan shall include the following information:

- Station numbers for the existing bridge to be removed.
- Description of the bridge: number of spans, length and width of bridge, number and types of bridge components.
- Sequence of bridge removal.
- List of equipment to be used including the make, model, number and size.
- List and description/drawings of any proposed temporary encroachments if applicable for removing any bridge components within or over a stream, water body or wetland. Temporary encroachments shall be submitted in accordance with Articles 107.09, 107.23, and applicable plan requirements.
- List of all materials and methods proposed to be used in accordance with the plans and stormwater best management practices to protect to the maximum extent practicable the water quality of the intersecting stream, water body or wetland during the bridge removal.
- Estimated length of time for the bridge removal.
- Plan for final disposition of materials removed.
- Photographs of the existing bridge.

No demolition work can start until the removal plan has been accepted and distributed. The Contractor and the Project Manager shall meet to discuss the removal plan prior to beginning any demolition work.

No existing bridge shall be removed or closed to traffic until satisfactory provisions for the passage of traffic have been made and approved by the Engineer.

When the plans provide for using old bridge substructures or parts of them as permanent parts of a new structure, only those portions shall be removed which are so indicated on the plans.

All portions of existing bridges, including debris, at or just above the mudline of a stream, water body, or wetland shall be removed unless otherwise specified on the plans. Otherwise, all portions of existing bridges may be either removed entirely or broken down to an elevation of at least 3 feet {1 m} below subgrade or natural ground.

During the removal of an existing bridge, no heavy equipment (except as noted above for temporary encroachments) shall be allowed in a stream, water body or wetland. Portions of an existing bridge over a stream, water body or wetland, including any piers/bents within them, shall be removed from the top down utilizing saw cutting or other approved methods which prevent to the maximum extent practicable debris from entering the water. Slurry from any saw cutting operations shall also be contained to the maximum extent practicable.

On navigable waterways, provisions shall also be made for waterway traffic in accordance with U.S. Coast Guard and/or Corps of Engineers, Rules and Regulations. The Coast Guard and Corps of Engineers shall be given notification of the dates and work procedures planned for the removal of existing bridges over navigable waterways. The Contractor shall give this notification at least 21 calendar days prior to the date of the beginning of the removal work.

Use of methods or equipment which might damage completed structures, structures to be retained, or portions of structures, will not be permitted.

Blasting will not be permitted without prior written approval of the Engineer. Blasting, if approved, shall be in accordance with Article 107.11.

Where portions of existing pavement, curb and gutter, walks, and similar items are to remain and join the surface of the new work, they shall be removed to an existing joint or cut off to a neat line with vertical face using saws or other approved equipment that will not damage the retained portion of the work.

Pipe that is not to be salvaged shall be removed or, if concrete, it may be broken up in place.

In removing manholes, inlets, etc., any live sewers connected with them shall be satisfactorily bypassed, rebuilt, and reconnected without additional compensation.

Removing railway or street railway tracks shall include removal of all rails, paving, switches, frogs, guardrails, ties, track, encasement, and other appurtenances. Ballast and concrete foundations shall be included unless otherwise directed.

Removing pipe headwalls shall include removal and disposal of the encased joint of pipe unless otherwise directed.

Rubble shall be removed in accordance with the requirements shown on the plans.

Walls and foundations that are not needed shall be removed to an elevation at least 2 feet {600 mm} below excavation limits in excavation areas, 3 feet {1 m} below subgrade in embankment areas and to ground level or as directed elsewhere.

All trenches and excavations resulting from the removal or breaking down of old culverts or structures shall be filled with suitable materials placed in accordance with Section 210.

Any reinforcing steel to be left in place to serve as dowels or ties shall not be injured by the removal of the concrete. Such dowels or ties shall be cleaned and straightened or bent as required to fit new work.

Removing cable guiderail shall include removal and disposal of all related items (Cables, end anchors, footings, posts, concrete pads, hardware, etc.) associated with the cable guiderail system.

206.04 Disposal of Materials.

(a) Designated Salvable Materials.

1. Where designated on the plans or in the proposal to be salvaged, all sound materials having salvage value shall be carefully removed without undue splitting or breakage and all bolts, nails, etc. shall be removed therefrom. The use of equipment or facilities which might damage members or portions of the structure to be salvaged will not be permitted. The Contractor will be held responsible for any damage due to his negligence in removing salvageable materials, and a sum, fixed by the Engineer as the value of the material so damaged shall be deducted from the Contractor's estimate.

No salvaged material shall be used in the construction of the new work, except where so provided on the plans or in the proposal, The Contractor shall not make temporary use of any materials or parts from old structures without the written permission of the Engineer, and any materials and parts so used shall be left at a designated point at the same site and in substantially the same condition in which they were removed from the old structure.

2. Structural steel, timber, or other salvable materials removed from old structures, unless otherwise specified or directed, shall be stored in a neat and presentable manner on blocking at designated locations within the right of way. Structures or portions thereof which are specified on the plans or in the proposal to be salvaged for reerection shall be stored in separate piles.

Special attention is directed to handling of salvaged bridge materials in that steel superstructures and frames, unless otherwise provided, shall be match marked and dismantled in an approved workmanlike manner and removed carefully so as to avoid damage.

3. Guardrail designated for salvage shall be carefully dismantled in condition for reerection and rail, cable, hardware, and posts stored as directed at accessible points for removal. Cable shall be rolled or spooled in suitable condition for hauling.

4. Cable Guiderail designed for salvage shall be carefully dismantled in condition to be reused and cable, hardware, and posts stored as directed at accessible points for removal or as directed in the plans. Cable shall be rolled rolled or spooled in suitable condition for hauling.

(b) Undesignated Materials.

When the plans or proposal do not provide for the salvaging of materials from existing roadway or bridge structures designated for removal, all materials from such become the property of the Contractor to be removed or disposed of by methods of his selection provided such does not conflict with other requirements of the specifications or will damage any existing work or facilities to be incorporated into the work.

(c) Disposal of Materials off the Right of Way.

Material and debris removed from the right of way shall be disposed of in a manner acceptable to the Engineer. Indiscriminate dumping of these materials on abutting property with or without the owners consent will not be considered satisfactory disposal. The Contractor must comply with all local, State and Federal laws and ordinances pertaining to the type material being disposed of and secure and submit written permission from the property owner for any disposal area. In addition he shall include in the disposal plan an acceptable plan for treatment of the area so as not to present an unsightly appearance, create a public nuisance or incur future maintenance problems for the Department.

206.05 Method of Measurement.

Each old bridge or portion thereof, each box culvert or culvert type structure, exclusive of pipe culverts to be removed and for which direct payment is to be made, will be designated on the plans by its station number and description, and for the purpose of measurement and payment will be considered a complete and separate unit.

The quantity of plain or reinforced concrete pavement, plain or reinforced concrete base, and cement treated base removed, including overlying surface, will be measured and the surface area computed in square yards {square meters}. The quantity of other surfaces and bases removed will be measured by cross sections as unclassified excavation.

Removing concrete or stone curb, combination curb and gutter, gutter and valley gutter, including any overlying surface material, will be measured in linear feet {meters}.

Concrete sidewalk and concrete crosswalk removed as directed will be surface measured and the area computed in square yards {square meters}.

The length of culvert pipe removed will be measured in linear feet {meters}.

The quantity of pipe headwalls, manholes, inlets, and catch basins removed will be the number of separate units.

The Removal of Rubble as described on the plans will be measured as one lump sum unit.

Guardrail removed as directed will be measured in linear feet {meters} along the top of the rail in place between extreme limits of an installation.

Railway track removed will be measured in linear feet {meters} of separate two-rail track. A turnout will be measured as a separate two-rail track beginning at the point of frog. Where rails have previously been removed, removal of the remaining crossties, concrete foundation, and all remaining track appurtenances will not be measured and paid for but considered as a part of clearing and grubbing.

Cable guiderail removal will be measured in linear feet {meter} along the length of the top cable from anchor to anchor. Removal shall include all items associated with the cable guiderail system. No additional costs will be paid for removal of associated items of the cable guiderail system.

206.06 Basis of Payment.

(a) Unit Price Coverage.

When the contract contains a unit price for any pay item listed in this Section, such item will be paid for at the contract unit price, which shall include cutting, removal, excavation and subsequent backfill incident to removal, and furnishing all materials, tools, equipment, labor, and incidentals necessary to complete the work as described. It shall also include necessary and required salvage, preservation, storage on the right of way, or disposal of the materials, all as provided herein.

The unit price for removal of concrete pavement or concrete base shall include removal of any overlying surface.

Payment for removal or partial removal of old bridges at designated stations will be made at the lump sum contract price for each bridge removed or partially removed as specified.

The contract unit price for the Removal of Rubble shall be full compensation for loading, hauling and disposing of the rubble described on the plans.

Payment for removal of all box culverts and culvert type structures will be made at the lump sum contract price for each culvert which shall include removal or partial removal as specified on the plans.

Material required for backfilling structures removed, in excess of overlying material excavated in their removal, will be paid for at the contract unit price for excavation of the classification used.

(b) Payment will be made under Item No.:

206-A Removal of Old Bridge, Station _____ - per lump sum
206-B Removal of Old Box Culvert, Station _____ - per lump sum
206-C Removing __*__ - per square yard {square meter}
206-D Removing __**__ - per linear foot {meter}
206-E Removing __***__ - per each
206-G Removal of Rubble – per Lump Sum

* Concrete Sidewalk, Concrete Pavement, Concrete Crosswalks, Concrete Bases, etc.
** Pipe, Guardrail, Curb, Curb & Gutter, Railroad Tracks, Cable Guiderail, etc.
*** Headwalls, Inlets, etc.

SECTION 208
REMOVAL AND REINTERMENT OF GRAVES

208.01 Description.

This Section shall cover the services necessary to remove, disinter, and reinter graves or remains found within the limits of the highway right of way. The removal, disinterment, and reinterment shall be in compliance with all State, County, and/or City rules and regulations. Reinterment shall be in approved, established cemeteries or burial grounds.

The number of graves specified in the contract is approximate only; the actual number may vary and will depend upon a close investigation of the existing burial site during preliminary grading operations. Only the number of graves actually moved as directed will be paid for at the contract unit price, and no claim will be allowed for extra compensation due to overruns or underruns of the items provided under this Section.

208.02 Materials.

All materials furnished for use in connection with work under this item must be acceptable to the Engineer and suitable for the particular work with which it is associated.

208.03 Construction Details.

(a) General.

In areas where graves or cemeteries have been located or suspected, the Engineer may direct the Contractor to perform such clearing and grubbing, stripping or excavation work as may be deemed necessary in a manner which will allow an examination of the area to ascertain if all graves have been properly located. After the area has been checked and disinterment of the graves or remains properly accomplished, the Engineer will authorize the Contractor to commence full grading operations. Cost of any clearing and grubbing, stripping, and/or excavation to accomplish the above details shall be considered as a part of the type work under which it is performed, and no additional compensation will be considered.

(b) Disinterment and Reinterment.

The removal, disinterment, and reinterment of remains shall be performed under the supervision of a qualified undertaker licensed to practice in the State of Alabama.

The Contractor shall be responsible for obtaining all of the necessary permits required by State, County, or City Authorities prior to beginning work under this Section.

In addition, the following services are considered to be essential and a part of the requirements of this operation:

1. Providing for ministerial service at the place of disinterment and reinterment.
2. Furnishing of a grave space at an approved established burial ground, unless otherwise noted on the plans or proposal.
3. Providing for proper legal notices for disinterment and reinterment.
4. Providing for opening and closing of each grave at the place of disinterment and reinterment.
5. Providing for the displacement of the existing burial box or, in case deterioration of the original box has occurred, providing a satisfactory new burial box for the displacement of the remains.
6. Providing for the relocation of existing grave markers and/or monuments or, in case none exist, providing a granite grave marker of at least 20 inches {500 mm} by 10 inches {250 mm} by 4 inches {100 mm}.

208.04 Method of Measurement.

The removal, disinterment, and reinterment of graves, when provided by the plans or proposal, shall be measured in individual grave units, with each grave actually removed and relocated considered as a separate individual unit.

208.05 Basis of Payment.

(a) Unit Price Coverage.

Each grave directed and actually removed and reintered shall be paid for at the contract unit price per each which shall be full compensation for furnishing all materials and services necessary to properly remove and reinter the remains on an approved site furnished by the Contractor or, when provided by plans or proposal, reinterment on a designated site all in accordance with State, County

and/or City rules and regulations, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

208-A Removal and Reinterment of Grave - per each
208-B Removal and Reinterment of Grave at Designated Site - per each

SECTION 209
MAILBOX RESET

209.01 Description.

This Section shall cover the work of permanently resetting mailboxes required to be removed from their original position inside the right of way.

209.02 Materials.

All new mailboxes and new support materials furnished shall meet the requirements shown on the plans.

The Contractor may re-use existing mailboxes or support materials if approved by the Engineer. Other materials shall be returned to the property owner if requested or disposed of by the Contractor.

209.03 Construction Requirements.

All work shall be done in a workmanlike manner in accordance with the requirements of local codes, ordinances, and U.S. Postal Service Regulations. Any materials lost or rendered unfit for re-use on account of negligence or improper handling by the Contractor shall be replaced by him without additional compensation.

209.04 Method of Measurement.

The number of mailbox reset installations will be the number of each type installation (i.e. single, double, or multiple) permanently reset as directed and accepted. No measurement or direct payment will be made for mailboxes removed only and not reset, or for mailboxes removed and temporarily reset.

209.05 Basis of Payment.

(a) Unit Price Coverage.

The number of mailbox reset installations, measured as above provided, will be paid for at the contract unit price each which shall be payment in full for all excavation, backfilling, resetting mailboxes and providing and installing all necessary mailboxes, hardware and support materials, and for all equipment, tools, materials, and labor necessary to complete the work. Materials required for, and the construction of, the specified turnout will be paid for under other items of work.

(b) Payment will be made under Item No.:

209-A Mailbox Reset, __*__ - per each
* Specify “Single”, “Double”, or “Multiple”, etc.

SECTION 210
EXCAVATION AND EMBANKMENT

210.01 Description.

The work under this Section shall cover the excavation, hauling, disposal, or compaction of all material not being removed under some other item which is encountered within the limits of the work and is necessary for all construction in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer. All excavation covered in this section will be classified as "Unclassified Excavation", "Muck Excavation", "Channel Excavation", or "Borrow Excavation", as described in this Section.

Attention is directed to the fact that the roadbed must be treated by one of the methods specified in Section 230, 231 or 232 before the placement of an overlying subbase, base, or paving structure will be permitted.

210.02 Materials.

(a) General.

All excavation within the right of way or easement limits will be known as Roadway and Drainage Excavation and will be classified as "Unclassified Excavation", "Muck Excavation" or "Channel Excavation". Excavation outside of the right of way or easement limits will be classified as "Borrow Excavation."

(b) Roadway and Drainage Excavation.

Soils data indicated on the plans is for estimating purposes only and the Department does not guarantee the accuracy thereof. Material designated for removal under embankment areas will be reclassified according to its condition at the time of removal.

1. Unclassified Excavation.

Unclassified Excavation shall consist of the excavation of all materials of whatever character encountered in the work, except Channel Excavation or Muck Excavation when such items are included as separate pay items in the plans or proposal.

2. Channel Excavation.

Channel Excavation shall consist of the excavation, removal, and disposition as noted or directed of all material necessary to provide inlet and outlet ditches or channels for drainage structures in accordance with plan details. However, unless specifically designated by plan details, such excavation will be classified as Unclassified Excavation.

3. Muck Excavation.

Material unsuitable for immediate reuse due to organic content, saturated to the extent it is somewhat fluid, and must be moved by dragline, dredge, or other similar type equipment which operates outside the area being excavated, will be classified as muck.

Unless explicitly authorized otherwise by the Engineer, before material is classified by the Engineer as muck, the Contractor will be required to demonstrate that the material cannot be removed by conventional methods and equipment normally used in the unclassified excavation operation. Conventional equipment includes all types of scrapers and dozers. If no item for Muck Excavation is provided in the plans or proposal, such excavation will be classified as Unclassified Excavation and payment will be made as outlined in Item 210.10(a)1.

(c) Borrow Excavation.

Prior approval of all borrow sources must be given; however, this does not relieve the Contractor from the full responsibility for the quality and quantity of the material used. Materials for borrow shall be in accordance with the following:

1. Embankment.

Materials furnished for embankments above water and below subgrade shall be any stable material which can be compacted to the specified density.

2. Improved Roadbed.

Materials furnished for the improved roadbed shall be any stable material meeting the requirements of Soil Classification A-1, A-2, A-3, or A-4, as determined by AASHTO M 145, within the following limitations.

a. Materials in the A-2 or A-4 Classification shall be submitted to the Central Materials and Tests Soils Laboratory for a Resilient Modulus test. The Resilient Modulus test results will then be evaluated by the Materials and Tests Engineer to determine the suitability for use as Improved Roadbed.
b. Materials of the cherty or float gravel type which have a maximum of 50% passing the Number 8 {2.36 mm} sieve and 100% passing the 4 inch {100 mm} sieve will not be required to conform to the Soil Classification noted above.
c. Industrial waste, a residue from a manufacturing operation, may be used provided the material is taken from "cold" piles which are approved by the Materials and Tests Engineer and the material is broken down by roadway operations or pit operations or crushing methods to allow approximately 100 percent passing the 4 inch {100 mm} sieve. However, isolated oversize particles up to a maximum diameter of 1 inch {25 mm} less than the thickness of the compacted layer may be used, provided such does not exceed 10 percent of the weight {mass} based on 1 square yard {1 m^2}, 6 inches {150 mm} deep. The weight {mass} of 1 square yard {1 m^2} will be calculated on the weight {mass} per cubic foot {cubic meter} of the material. This material shall have a unit weight {mass} of not less than 100 pounds per cubic

foot {1600 kg/m³}, dry as determined by AASHTO T 99, Method "A" or "C", and conform to the following Composition Table:

Composition Sieve	% Passing By Weight {Mass}
4" {100 mm}	100
Liquid Limit (L.L.)	25 Max.
Plasticity Index (P.I.)	6 Max.
CBR	12 Min.

Material meeting this specification will not be required to conform to any Soil Classification noted above.

3. Underwater Backfill Material.

Material for underwater backfill shall be selected sandy material of an A-3 Classification or an approved A-1 or A-2 material of which not more than 15 percent passes the Number 200 {75 µm} sieve. A rocky material that will form a firm foundation when deposited under water may also be acceptable.

4. Underwater Embankment Materials.

Material for underwater embankment shall be secured from quarries designated on the plans or from other approved sources, producing equally satisfactory material. The material shall consist of 1/2 cubic yard {0.5 m³}, and smaller, size stone taken from approved natural rock formations. The material shall be free from earth or other foreign material consisting of predominantly larger size stones. Material to be used for choking or blanketing the surface of the underwater embankment shall be of sandy or fragmentary nature, such as stone spalls or screenings, float gravel, or gravel. Material that will slake or become plastic in water shall not be used as choking material or in the blanket course. NOTE: Certain materials within the roadway excavation limits may be authorized for use as improved roadbed material, underwater backfill, or underwater embankment; however, such authorization shall be in accordance with the provisions of Article 106.08.

210.03 Construction Requirements.

(a) General.

Prior to beginning excavation and embankment operations in any area, all necessary clearing and grubbing of the area shall have been performed in accordance with the provisions of Section 201, Clearing and Grubbing. Grading operations should commence as soon as possible after the beginning of the clearing and grubbing operations. Once grading operations begin, the work shall be continuous towards completing excavation and embankment unless approved otherwise in writing by the Engineer. Exposed erodible cuts and fills shall be final dressed, topsoil shall be placed, and the ground surface shall be stabilized with mulch and permanent seeding. The mulch and permanent seeding shall be placed in vertical increments not exceeding 20 feet {6 m} as the work progresses. Embankments shall be constructed with temporary earth berms to divert runoff to cut slopes or temporary pipe as the work progresses. Final grading and permanent stabilization measures shall be initiated for cut slopes by the end of the next business day of meeting the limits of vertical grading increments or upon suspension or completion of grading operations in a given area. Final grading and permanent stabilizations of embankments shall be initiated by the end of the next business day of reaching subgrade.

Special attention is directed to the requirements given in Section 665 and Sections 652 through 659 pertaining to the establishment of temporary and permanent erosion and sediment control measures.

The excavation and embankment for the work shall be constructed and maintained so as to properly drain and have reasonably smooth and uniform surfaces. The final subgrade elevation and section of both cuts and fills shall be in reasonably close conformity to that specified by the plans or directed (i.e. plus or minus 1 inch {25 mm} from the designated grade and slope elevations). No material shall be wasted without permission of the Engineer. Excavation operations shall be so conducted that material outside of the limits of the slopes will not be disturbed.

Choice of equipment to perform the work shall be that of the Contractor. The type and number of units shall be such as to perform the excavation and embankment operations in conformity with these specifications and secure the density specified. Supplemental equipment shall be furnished as necessary to keep the work properly shaped.

When the Contractor's excavation operations encounter artifacts of historical or archeological significance, the operations shall be temporarily discontinued. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow

for their removal. Such excavation, unless otherwise provided, will be considered and paid for as extra work.

Where portions of existing pavement are to remain and join the surface of the new work, they shall be cut to a neat line with a vertical face using saws or other equipment that will not damage the retained portion of the work.

(b) Roadway Excavation.

1. General.

All intersecting roads, approaches, entrances, and driveways shall be graded and completed concurrently with the roadway grading and shall be kept passable at all times. During the grading operation, the area being graded shall be maintained reasonably smooth and well drained. Material used as directed by the Engineer for temporary surface to permit public use of the project will be paid for at the contract unit price of the materials so used. The Contractor shall maintain this temporary surface.

Cuts may be widened and the slopes varied as directed during construction, according to the stability of the material encountered and the need for embankment material; however, benching of backslopes in order to obtain material will not be permitted unless authorized in writing. If widening of a cut is necessary after the backslope is completed, a width sufficient to accommodate normal grading equipment will be allowed. Unauthorized excavation beyond the required slope will not be paid for.

Old roadways within the Right of Way shall be obliterated as directed. Roadway obliteration will be paid for as Unclassified Excavation, unless otherwise designated on the plans.

2. Removal of Topsoil.

Topsoil within the construction limits shall be removed in the areas and to the depth as directed by the Engineer. Topsoil may include sod, but not tall vegetation or other debris, and shall be kept free from subsoil. It shall be stockpiled in approved locations with each stockpile not less than 4 feet {1.2 m} high, and containing not less than 200 hundred cubic yards {150 m^3}. Each stockpile shall be shaped as necessary to permit accurate cross sections. The work of removal and stockpiling of topsoil will be paid for as Unclassified Excavation.

Temporary or permanent seeding, mulching and other erosion control measures shall be applied as directed by the Engineer and will be paid for under the appropriate items of work.

3. Selective Grading.

Certain designated zones or portions of cuts which afford the more suitable soils for roadbed construction shall be reserved as directed for use in forming the upper graded earth layer or layers for embankments or cuts, for backfilling, and for other purposes. Should it become necessary to stockpile selected material for use below the subgrade elevation of the same cut, it may be stockpiled nearby so that the excavated material can be measured for payment for the rehandling.

4. Undercutting.

a. Soil.

Unless noted otherwise on the Plans, cuts in soil shall be undercut 1 foot {300 mm} where improved roadbed is required. Undercut areas shall be further undercut if the Engineer determines that this is necessary for the removal of soft or yielding areas. The areas of increased undercutting shall be shaped to drain, backfilled with a suitable material and uniformly compacted to the density specified for embankment.

The length of a section of undercutting shall be a minimum of 25 feet {7.5 m}.

Areas where improved roadbed is not required shall also be undercut if the Engineer determines that this is necessary for the removal of soft or yielding areas. These areas shall also be shaped to drain, backfilled with suitable material and uniformly compacted to the density specified for embankment.

All depressions in undercut sections shall be cleaned out and provisions shall be made for drainage. The depressions shall be backfilled and compacted with selected materials approved by the Engineer.

Undercutting will be measured and paid for as Unclassified Excavation.

b. Rock.

Cuts in rock shall be undercut 1 foot {300 mm} only where the rock does not extend above the subgrade across the full width of the improved roadbed.

All depressions in cuts in rock shall be cleaned out and provisions shall be made for drainage. The depressions shall be backfilled with a crushed aggregate base material meeting the requirements of Section 825 or a quarry crusher-run material suitable for the intended purpose. The backfill shall be compacted as directed by the Engineer.

There will be no direct payment for the material required to fill depressions made in rock cuts where the depressions resulted from the removal of rock.

5. Excavation and Backfill of Muck.

Excavation and backfill of muck areas shall be performed in a manner, acceptable to the Engineer, that will not permit the entrapment of muck within the backfill. The backfilling of the excavated area shall follow immediately behind the excavation so that any soft material that is pushed ahead of the backfill can be removed. After muck removal, the Contractor shall allow the Engineer adequate time to take all elevations and measurements necessary for determining the volume removed.

Normally, the material used to backfill the excavated muck areas will be selected Unclassified Excavation or Borrow Excavation, Item 210-A or 210-D, as shown on the plans or directed by the Engineer.

When directed in writing by the Engineer, the material used to backfill the excavated muck areas will be Borrow Excavation (Underwater Backfill or Underwater Embankment), Item 210-E or 210-F, meeting the requirements of Subarticle 210.02(c).

Backfill material placed in water shall be so deposited that its weight {mass} will displace and force any remaining muck outward and ahead of the backfill, and prevent trapping of muck pockets. Back-pressure from displaced muck against the toe of the advancing backfill shall be relieved promptly by excavating the displaced muck as fast as it accumulates. Dikes ordered constructed within the right of way limits for controlling the muck will be paid for as Unclassified Excavation.

In addition to the requirements of Article 210.05 for disposal areas, where directed, dikes shall be built (without extra compensation) to keep the deposited muck within the limits of the designated areas and as soon as the surface condition of the deposited material will permit, the Contractor shall remove all visible stumps, roots, logs, and other debris from the waste pile and shall dispose of them as specified in Subarticle 201.03(e) without extra compensation. Before acceptance of the work, all parts of the waste pile shall be drained and dressed to a pleasing and reasonably uniform surface and any necessary erosion control work performed, all as directed by the Engineer.

6. Excavation of Rock.

Unless otherwise shown on the plans, the Contractor shall use the presplitting technique to split the face of the rock cut in a relatively smooth plane along the designated backslope, prior to shooting the interior portion of the cut. Presplitting shall be accomplished by drilling holes at intervals of approximately 1.5 feet {500 mm} to 3 feet {1 m} to the proper depth along the designated slope, loading and stemming such holes with an appropriate light charge of explosive and detonating all holes simultaneously. The Contractor will not be required to presplit on slopes flatter than one to one. In the event the cut is too deep for the presplitting to be done in one operation, an 18 inch {450 mm} offset will be allowed for the subsequent presplitting operations after the initial presplitting and interior blasting.

Any material outside the designated side slopes that has been loosened or shattered by blasting shall be removed to provide a reasonably smooth and uniform slope. No rock shall project more than 1 foot {300 mm} inside the designated slope. Payment will be made for overbreakage and necessary backfill material for a distance not to exceed 1 foot {300 mm} outside the designated slopes or 1 foot {300 mm} below the designated elevation for undercutting; however, where presplitting is required, no overbreakage on side slopes will be paid.

All overbreakage in excess of the noted limits shall be removed and necessary backfill performed by the Contractor without additional compensation.

When authorized in writing, rock from roadway excavation may be used under other sections of the Specifications. In such event, payment will be made under the appropriate Section for which the rock is so used, and as provided in Section 106 for the replacement of materials for use in the embankment.

All rock that is not required for other construction shall be placed in embankment, insofar as possible, in accordance with the provisions for embankments. Large rock or boulders that cannot be used in embankment shall be disposed of by the Contractor.

7. Benching.

In cuts where unstable soil conditions occur, the plans may designate or the Engineer may direct the use of benching. The benching shall be accomplished by suitable drilling and blasting equipment when so directed. This benching will be measured and paid for as Unclassified Excavation.

Benching may also be ordered to provide a more stable foundation for heavy embankment. Benching shall be accomplished by excavating horizontally along the hillside down to or into rock or other suitable undisturbed foundation material, forming a series of stepped benches. Each bench shall be in excavation for its entire width. The benches generally shall parallel contour lines. They shall be constructed at least 10 feet {3 m} wide and may be required to be wider for better support of embankment. Benching of embankment will be measured and paid for as Unclassified Excavation only if it is required to be loaded onto equipment and hauled to another location.

(c) Borrow Excavation.

All stumps, logs, brush, roots, and other debris resulting from clearing and grubbing work in borrow pits shall be removed and disposed of as specified in Subarticle 201.03(e). No separate payment will be allowed for this operation.

Material unsuitable for use in the work shall be disposed of in a satisfactory manner and the amount of such deducted or eliminated from quantities measured for pay purposes.

All borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavating has been completed. The Contractor shall notify the Engineer in sufficient time before beginning excavation so that the necessary cross sections may be taken. The finished borrow areas shall be left in a condition satisfactory to the Engineer and the property owner. Attention is directed to Subarticle 106.01(b) for conditions governing local pit operations.

The selection of areas of the source for use and sequence of excavation shall be as directed by the Engineer in order that material of the best available gradation and soil characteristics may be secured.

(d) Embankment.

1. General.

Only suitable, approved materials shall be used in the work. The Engineer shall be the sole judge of the suitability of materials and may require such selection of materials as may be necessary to insure a satisfactory embankment. Sandy or rocky materials available shall be used to the extent practical across wet areas to form a floor for supporting the required embankment.

After clearing and grubbing of the embankment areas is complete, all cavities and irregularities shall be enlarged to permit use of compaction equipment, backfilling and compacted as required. Foundation preparation shall consist of the work required to provide a stable foundation for the embankment. This may consist of undercutting and backfilling, flooring sufficient to support equipment, or other work as may be directed. Foundation preparation and compaction will be as directed by the Engineer.

Where embankment is to be placed on old concrete pavements or pavements having concrete bases, the treatment of the old concrete shall be as specified on the plans. Where embankment is to be placed on any other type of roadway pavement or surface, the existing pavement or surface shall be scarified to the extent necessary to provide ample bond between old and new material.

2. Embankment Formation.

Rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

Roadway embankment of earth material shall be placed in reasonably uniform layers not exceeding 8 inches {200 mm} (loose measurement) and, insofar as practical, the full width of the embankment section. Each layer shall be compacted as specified before the next overlying layer is placed. Care shall be taken during the compaction operations so that uniform density is obtained.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the thickness prescribed without crushing, pulverizing, or further breaking down of the pieces resulting from excavation methods, such material may be placed in the embankment as directed in layers not exceeding 2 feet {600 mm} in thickness. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments or earth. These type lifts shall not be constructed above an elevation of two feet {600 mm} below the finished subgrade. The balance of the embankment shall be composed of suitable material (no material larger than 4 inches {100 mm}) smoothed and placed in layers not exceeding 8 inches {200 mm} in loose thickness and compacted as specified for embankments.

Placing of large stones, up to two-thirds the remaining embankment height at the point of placement, will be allowed provided they are spaced so as to permit free access of proper equipment to compact the intervening fill in normal layers. Other large stones may be placed on fill slopes as directed.

When new embankment is to be placed against existing embankments, or when embankment is built one-half width at a time and slopes are steeper than 4:1 {1:4} when measured at right angles to the embankment, the old embankment shall be continuously benched and the new work brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment, but in no case less than 6 feet {2 m}. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense.

Underwater backfill and underwater embankment shall be deposited in one layer for the full width of the embankment, or as directed, to the elevation designated on the plans or directed. In the formation of underwater embankment, the rock shall be fully choked with a blanket of approved choking material before placement of the remaining embankment.

Embankment over, under, and around structures (pipes, culverts, arches, bridges and like), except pipes and arches 48 inches {1200 mm} or less in diameter, shall be selected embankment material placed and compacted or tamped as noted herein in a manner and by methods that will avoid unbalanced loading, cause movement, or place undue strain on any structure. Attention is directed to Section 530 for pipes and arches 48 inches {1200 mm} or less in diameter. The Contractor shall be solely responsible for protecting the structures and any damage to any part of a structure due to not providing proper protection shall be cause for ordering its replacement without additional compensation.

3. Embankment Compaction.

Layers of embankment shall be compacted as specified in Subarticle 306.03(b). Strict moisture control will not be required; however, it will be the Contractor's responsibility to maintain the moisture content necessary to satisfactorily compact the material. Compaction in a semi-dry condition will not be permitted.

Where improved roadbed design is specified, the layers up to the bottom of the improved roadbed shall be compacted as noted above and finished true to required line, grade, and cross section. The improved roadbed layers shall then be constructed as provided in Article 230.03.

Where improved roadbed design is not specified, the embankment layers shall be continued up to subgrade elevation with the same compaction requirement as noted herein. Just before placing a subbase or other material on this graded earth roadbed, the top 6 inches {150 mm} shall be reconstructed as provided in Subarticle 230.03(c) of these specifications.

No compaction or density test will be required for underwater embankment or underwater backfill.

210.04 Use of Materials.

All suitable materials removed from the Roadway Excavation shall be used, insofar as practicable, in the formation of the embankment, roadbed, base layers, shoulders, slopes, bedding, and backfill for culverts, and for such other purposes and places as directed. Suitable materials shall be defined as those suitable for any of the above listed uses.

No excavated material shall be wasted unless permitted in writing by the Engineer but shall be used uniformly to widen embankments, to adjust grades, to flatten slopes, or shall be deposited in such places and for such other purposes as may be directed. Such material shall be handled as follows:

1. Suitable Material.

Suitable material shall be used at the time of excavation for any of the purposes outlined herein in this Article. It is not intended to stockpile suitable material unless ordered in writing by the Engineer. Payment for second handling will be made only when reused from stockpiles previously ordered by the Engineer.

2. Unsuitable Material.

Unsuitable material that cannot be used at the time of excavation may, at the option of the Contractor, be temporarily stockpiled within the right-of-way, or the Contractor may make written request for disposal as waste in an approved area on or off the right-of-way. Payment for the second handling of stockpiled unsuitable material will be made only when ordered in writing for use by the Engineer for a specific pay item. The remainder of the stockpiled material may be used to widen embankments, flatten slopes, etc. as allowed by the Engineer, with no payment for the second

handling, or shall otherwise be disposed of off the right-of-way with no payment for the second handling.

No payment will be made for the second handling of unsuitable material deposited outside the construction limits at the time of excavation and later spread onto a fill slope, etc. by use of a dozer or similar equipment.

3. Channel Excavation.

Channel Excavation shall be used to fill old channels, in the construction of embankments, the flattening of slopes, or shall be disposed of as approved by the Engineer. If permitted by the Engineer, waste channel excavation may be spread in uniform layers, neatly leveled, shaped, and grassed with sufficient openings provided to permit surface drainage of adjacent lands; however, in no case will waste material piles be permitted to remain within 10 feet {3 m} of the edge of any ditch, channel, or cut. No payment will be made for any necessary rehandling of Channel Excavation material unless ordered for use by the Engineer from stockpiles for a specific pay item.

210.05 Disposal Areas for Surplus Material.

If no disposal areas are shown on the plans, the Contractor shall provide at his own expense disposal areas and submit along with the permission of the property owner a plan for treatment of the area which is acceptable to the Engineer. Said plan shall provide for dressing, grassing, or other treatment to avoid unsightly appearance and not create a public nuisance or incur future maintenance problems.

Disposal areas will not, in general, require clearing and grubbing or compaction of the waste pile; however, if clearing and grubbing or compaction is required, such will be designated by plan details or in the proposal.

Reference is made to Item (f) of paragraph 3 of Article 107.13 concerning handling of waste material and treatment of areas.

210.06 Finishing and Dressing.

All the completed work shall be dressed and maintained substantially to the lines, grades, and cross sections shown on the plans or as directed by the Engineer. Slopes shall be shaped, rounded, finished, or trimmed in a neat workmanlike manner to conform to the slope lines shown on the plans or as modified by the Engineer. Care shall be exercised that no material be loosened beyond the required slopes.

Compensation for all such finishing and dressing shall be included in the contract unit prices and no direct payment will be made for this work.

210.07 Erosion Control.

The Contractor shall incorporate into the work all permanent erosion control features provided in the contract at the earliest practical date. In addition, temporary erosion control features may be ordered by the Engineer to facilitate protection until the permanent control features can be installed. Stockpiles shall be located away from stormwater conveyance and outside areas having a potential to flood during a local 2-year, 24-hour storm event. Stockpiles shall have a sediment barrier installed along all downgradient areas. Temporary and permanent erosion control features shall be initiated by the end of the next business day, following the day when construction activities will temporarily cease for more than 7 days or permanently cease. Particular attention is directed to Section 665 and Article 107.21 of these Specifications.

210.08 Blank.

210.09 Method of Measurement.

(a) General.

Measurement for all accepted Excavation, except for Borrow Excavation for Underwater Embankment, will be either by the cubic yard {cubic meter} of the material in its original position computed from cross sections by the average end area method or per ton {metric ton} as specified by the unit measure of the pay item.

Measurement for Borrow Excavation for Underwater Embankment will be either by the ton {metric ton} or by the cubic yard {cubic meter}, loose volume, of the material in the hauling vehicle at the point of use as specified by the unit measure of the pay item.

Embankment will not be measured for payment. All of the operations required for embankment formation described herein shall be considered necessary work incidental to and for which compensation is included in the contract unit prices for the pay items of the materials composing the embankment.

Muck excavation as described in Subarticle 210.03(b) will require the use of the following modified cross section and average end area method. The volume will be measured between theoretical vertical side slopes, a station or substation at a time, immediately after completion of muck excavation and before backfill is placed. No measurement or allowance will be made for necessary excavation of material for sloughing, subsidence, flattening sides, slumps, or rehandling materials or for shaping and dressing disposal areas. The sloughing, subsidence, flattening, or slump of side slopes in muck will not be classed as slides.

(b) Measurement Limitations.

Measurement of pay quantities will not include any excavated material used for purposes other than those designated except as provided under Article 106.08. Where material has been excavated beyond the designated slope line and wasted, the unauthorized wasted material will be measured and deducted from the excavation quantities. Any material excavated prior to the staking out and cross sectioning of the borrow sources by the Engineer, or in excess of that ordered for the work, will not be included in the quantity measured for payment. If the Contractor places more borrow than is necessary, thereby causing a waste of excavation, the amount of such waste will be deducted from the borrow excavation as measured in the borrow source. When a borrow area is adjacent to the right of way, the dividing line between unclassified excavation and borrow excavation shall be either a vertical plane through the right of way line or the proposed backslope as shown on the plans, whichever is most economically advantageous to the State.

210.10 Basis of Payment.

(a) Unit Price Coverage.

1. Roadway and Drainage Excavation.

The accepted volume of Unclassified Excavation - Item No. 210-A, Channel Excavation - Item 210-B, and Muck Excavation - Item No. 210-C, when provided in the plans or proposal, measured as provided above, will be paid for at the contract unit prices bid for these items which shall be payment in full for: excavation; disposal of surplus and unsuitable materials (see Articles 210.04 and 210.05); hauling; formation and compaction of embankment; preparation and completion of subgrade and shoulders except when this work is included in other pay items; the completion of all cuts, embankments, and channel excavation to conform to the lines, grades, and cross section indicated on the plans or otherwise directed; and the completion of the roadway together with its appurtenances of intersecting roads, streets, driveways, approaches, temporary drainage facilities, and other related incidental work for which the proposal contains no contract unit prices. The said contract unit prices for the excavation item shall be payment in full for all equipment, tools, labor, and incidentals necessary to complete the work.

If no contract items for Channel Excavation and/or Muck Excavation are provided, such work will be paid for as Unclassified Excavation.

Exceptions to the above will be made in the event of the following:

a. If a backslope already completed and dressed is destroyed by a slide, or if the Engineer orders additional material taken from a completed and dressed backslope, any redressing required will be paid for as provided in Article 104.03.
b. If a slide occurs after completion of the subgrade to line and grade or during subsequent work in the immediate area and is of such nature and extent that the Engineer, in order to avoid damage to the previous work, directs its removal, and such requires equipment other than equipment normal to the project, an adjustment in price may be made. However, in no case shall such increase exceed 25 percent of the unclassified excavation contract unit price.
c. If no item for Muck Excavation is provided in the plans or proposal, such excavation will be classified as Unclassified Excavation and payment will be made at two times the unit bid price for Unclassified Excavation.

2. BORROW EXCAVATION.

The accepted volume of Borrow material designated under Items 210-D, 210-E and 210-F, measured as noted above, will be paid for at the contract unit price bid for the items, which shall be payment in full for the royalty and other expenses incidental to procurement, construction and maintenance of haul roads, clearing and grubbing, stripping, excavating, loading, hauling, source moves, dumping, spreading, and also for formation and compaction of embankment, trimming slopes, disposing of surplus materials, preparation and completion of subgrade, shoulders, and intersecting roadways and furnishing of all equipment, labor and incidentals necessary to complete the work. This

pay item also includes any necessary work as may be required by the Engineer or Owner in the final dressing of the pit, including grassing or other landscape work.

(b) Blank.

(c) Payment will be made under Item No.:

210-A Unclassified Excavation - per cubic yard {cubic meter}
210-B Channel Excavation - per cubic yard {cubic meter}
210-C Muck Excavation - per cubic yard {cubic meter}
210-D Borrow Excavation - per cubic yard {cubic meter}
210-E Borrow Excavation(Underwater __*__) - per cubic yard {cubic meter}
210-F Borrow Excavation(Underwater __*__) - per ton {metric ton}
* Specify either Backfill or Embankment.

SECTION 212
MACHINE GRADING SHOULDERS

212.01 Description.

This Section shall cover the work of reconstructing the shoulder of a roadway where the grading is of such character that the material can be moved, mixed, and shaped with a motor patrol of adequate power and weight {mass}.

In general this work shall consist of clipping the shoulder, where directed, prior to resurfacing and blading the shoulder after the resurfacing has been completed. Any additional material needed to bring the shoulder to the desired profile will be classified and paid for under the appropriate section for the type material furnished.

If seeding or other items are needed for erosion control, such items will be shown on the plans and paid for under the appropriate specification section.

Unless otherwise noted by plan details, the completed work shall conform to the shoulder requirements for lines, grades, and typical section indicated by the plans or established by the Engineer.

212.02 Material.

Material used under this Section shall be of the quality and character noted on the plans or ordered by the Engineer, suitable for the purpose intended and consistent with the requirements for such material noted in other parts of this specification.

212.03 Construction Requirements.

(a) General.

Clipping, or blading, of grass and soil from the shoulder, as provided by the plans or directed, shall be completed in advance of resurfacing operations. The removed material shall be windrowed a sufficient distance and in such a manner as not to pose a safety hazard to the motoring public. Where directed, the entire width of the shoulder shall be plowed, scarified or otherwise loosened. The shoulder then shall be re-formed by blading the material from the windrows, or by the addition of extra material as specified or directed, with the machine grader and compacting it to the satisfaction of the Engineer. Watering shall be used, as necessary, to aid compaction. The machine grading shall continue until the shoulder is completed to conform to the lines, grades, and typical section shown on the plans or directed.

(b) Equipment.

The Contractor shall provide appropriately sized equipment in sufficient numbers to perform the work within the guidelines noted herein and the time frame for the contract.

(c) Additional Material.

It will be considered practicable to move material up to 100 feet {30 m} longitudinally by means of the machine grader and all material moved within that limit will be paid for in the contract price for machine grading shoulders. When it is necessary to waste surplus material, such material shall be wasted on the front slope of the roadway in the vicinity of the removal site, to the satisfaction of the Engineer. Material secured from sources outside the right of way will be classified under the applicable classification.

212.04 Method of Measurement.

Accepted machine grading of shoulders will be measured in hundred-foot {100 m} stations and fractions thereof to the nearest foot {1 m} of shoulder along the centerline of roadway, complete in place. Each shoulder graded will be measured separately.

Borrow Excavation, Topsoil, or other material ordered used will be measured and paid for as provided by their appropriate sections unless otherwise specified.

212.05 Basis of Payment.

(a) Unit Price Coverage.

Machine grading of shoulders, measured as noted above, will be paid for at the contract unit price per station for machine grading, complete in place, which price shall be full compensation for the preparation, construction, and maintenance of the work involved, including blading, spreading, compacting, and dressing and for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

212-A Machine Grading Shoulders - per station

SECTION 214
STRUCTURE EXCAVATION AND BACKFILL FOR DRAINAGE AND MINOR STRUCTURES

214.01 Description.

(a) General.

The work under this Section shall consist of the removal and disposal of all excavated materials of any nature required for the construction of all box type culverts (including bridge type), pipe culverts (including pipe arches), storm drains, and other minor structures in accordance with these Specifications and to reasonably close conformity with the lines and grades shown on the plans or designated by the Engineer. This Section shall further include backfilling of structure foundations with suitable material in accordance with plan details or as directed.

(b) Classification of Materials.

1. Excavation.

All excavation for structures below natural ground or the designated subgrade, whichever is lower, or the elevation designated by the Engineer will be classified as Structure Excavation and shall include all materials encountered regardless of their nature, exclusive of water or other liquids which will not be classified as excavated material, necessary for the proper construction of the structure.

Excavation for ditches at the inlet and outlet ends of drainage structures and any other ditches indicated on the plans shall be constructed under "Roadway and Drainage Excavation" items.

2. Backfill.

a. Foundation Backfill.

Special selected material ordered placed under a structure to provide a suitable foundation for the structure shall be classified as Foundation Backfill.

b. General Backfill.

Material used for ordinary backfill shall include special material for areas immediately adjacent to weepholes and a drainage belt for large masonry structures.

214.02 Material.

(a) Foundation Backfill.

Foundation Backfill is a special selected material suitable (approved free-draining commercial or local material) for use as foundation for the structure.

(b) General Backfill.

Material used for general backfill shall be a compactible soil of acceptable quality except that material for areas immediately adjacent to weepholes shall be free draining material conforming to the following:

1. Local material shall have a permeability coefficient of at least 0.1 mm/sec., measured by the AASHTO T 215 constant head permeameter, with 90% passing the 3/4 inch {19.0 mm} sieve and a maximum of 10% passing the Number 8 {2.36 mm} sieve.
2. Commercial material shall be aggregates meeting the requirements of ALDOT #467 or ALDOT #57. Other commercial aggregates will be considered and can be used if approved by the Materials and Tests Engineer.

214.03 Construction Requirements.

(a) General.

Foundation excavation shall be of the size and depth conforming to the outline for the structure shown on the plans or established by the Engineer. Unsuitable foundation material below the normal design elevation shall be removed as directed by the Engineer and paid for as Structure Excavation.

Where rock, gravelly soil, hard pan, or other unyielding material is encountered, it shall be removed as ordered by the Engineer for a depth of at least 12 inches {300 mm} below the designated grade. This extra depth of excavation shall be backfilled with suitable, approved material measured and paid for as foundation backfill.

Attention is directed to the special requirements for placement of pipe culverts in embankment areas noted in the plans.

(b) Excavation.

Choice of equipment to perform the excavation within the limits of the lines and grades noted in this Section or directed shall, in general, be that of the Contractor provided such produces the desired results without injuring any adjacent or adjoining work.

Special care shall be taken not to disturb or loosen foundation material below designated foundation limits.

Unless otherwise indicated in the plans or directed by the Engineer, all sheeting and bracing used in making structure excavation shall be removed by the Contractor following the completion of the work.

(c) Backfilling.

1. Foundation Backfill.

Foundation backfill shall be deposited uniformly for the full width of the excavation in horizontal layers not to exceed 6 inches {150 mm} in thickness with each layer compacted as directed by the Engineer.

2. General Backfill.

General backfilling consisting of all backfill except foundation backfill shall be performed in accordance with the requirements of Section 210 and Section 530 with particular attention directed to the requirements for protecting structures.

No backfill shall be placed against a newly constructed masonry or concrete structure for a period of 10 days unless authorized by the Engineer.

Large masonry or concrete structures such as box culverts and retaining walls, etc. shall have a deposit (belt), not less than 1 foot {300 mm} wide and 1 foot {300 mm} deep, of approved local or commercial free draining material placed full length along the back face of the vertical walls at the line of weepholes. This material must conform to the requirements specified under Subarticle 214.02(b).

Small structures such as inlets, etc. and top slabs of culverts having weepholes shall have approximately 1 cubic foot {0.03 m^3} of approved commercial free draining material, as specified in Subarticle 214.02(b), placed at each weephole.

Placing of the material at weepholes shall be done in such a manner as to provide maximum depth of filtering effect.

Prior to the placing of any free draining material, each weephole shall be protected by rough stones, a grooved concrete block, or hardware cloth to permit seepage yet prohibit loss of material through the weephole.

No direct payment will be made for the operation or the special material noted above for treatment of weepholes.

214.04 Method of Measurement.

(a) Structure Excavation.

1. Quantity of Excavation.

The quantity of excavation will be the number of cubic yards {cubic meters}, measured in its original position, that is excavated in accordance with the details shown on the plans and the following limitations.

2. Masonry Structures other than Culverts.

For masonry structures other than culverts, measurement will be made of material removed from the area bounded by vertical planes 1 foot {300 mm} outside of the neat lines of the foundation or footing plan and parallel thereto, and to the elevations shown on the plans or directed by the Engineer to provide installation on a suitable foundation. No measurement or payment will be made for material excavated outside these limits.

3. Excavation for Culverts.

For box, arch, and pipe culverts with wing walls or headwalls or other minor structures including storm sewers, measurement will be made of the material removed in accordance with the following:

The excavation shall be considered to be a trench with vertical sidewalls. No separate measurement for minor structures (inlets, junction boxes, catch basins, manholes, etc.) other than noted below, such being considered incidental to work.

The length of the excavation shall be the actual length of the structure (including inlets, junction boxes, etc.) measured along the flowline plus 1 foot {300 mm} at each end. When headwalls or wing walls are used, the length shall be the average net length of the structure, tip to tip of wings.

The width of the excavation shall, in the case of pipe structures, be considered the inside diameter of the pipe plus 3 feet {1 m}. For box culverts, the width shall be the outside width of the barrels plus 4 feet {1.2 m}. On all culvert structures, no allowance will be made for wing flares or toe walls.

4. Depth of Excavation.

The depth of excavation will be as deep as required to install the structure on a suitable foundation to the flowline indicated. This depth shall then be measured in accordance with the following:

a. Pipe of inside diameter of 48 inches {1200 mm} or less shall be laid in a trench extending at least 1 foot {300 mm} above the elevation of the top of the pipe. The depth of excavation shall be measured from a point 1 foot {300 mm} above the top of the pipe, or from subgrade elevation in cut sections.
b. For box culverts and pipe larger than 48 inches {1200 mm} in diameter, cross sections of the original ground will be taken at major breaks in the ground line profile and at changes in the culvert barrel widths along the length of the culvert as defined in Item 2 above.

5. Computation of the Volume of Excavation.

The average end area method shall be used in computing the volume and no measurement for payment will be made for material excavated outside of the limits noted above.

6. Excavation For Side Drain Pipe.

No measurement or payment will be made for excavation for side drain pipe of any size or for side drain culverts unless so provided by plan details. The cost of such excavation shall be included in the price bid for the items; however, pipe designated on the plans as storm sewer pipe will not be classified as side drain.

(b) Foundation Backfill.

Foundation backfill will not be measured directly but the volume will be fixed at 150 percent of the volume of the excavation which it replaces that lies between the bottom of the structure and the bottom elevation of the trench ordered excavated. Where satisfactory structure foundation is provided by the normal process of removing and backfilling unsuitable material under fill areas, none of such backfill will be classified as foundation backfill.

214.05 Basis of Payment.

(a) Structure Excavation.

Payment will be made for the number of cubic yards {cubic meters}, measured as detailed above, at the contract unit price bid for Structure Excavation.

Such payment shall be payment in full for furnishing all materials, equipment, tools, labor, pumping, bailing, draining, and all incidentals necessary to complete the work and shall include installation and removal of any cribs, cofferdams, shoring, sheeting, or other protection, the satisfactory disposal of any unsuitable material from the excavation, and the placement and compaction in backfill or embankment of the material excavated and suitable for such use.

(b) Foundation Backfill.

Payment for the calculated cubic yards {cubic meters} of this material, determined as noted herein, will be made at the contract unit price bid which shall be full compensation of the item complete in place and includes furnishing of all material, placement, compaction and all equipment, tools, labor, and incidentals necessary to complete the work.

(c) Payment will be made under Item No.:

214-A Structure Excavation - per cubic yard {cubic meter}
214-B Foundation Backfill, Local/Commercial - per cubic yard {cubic meter}

SECTION 215
EXCAVATION FOR BRIDGES

215.01 Description.

The work under this Section shall cover foundation excavation for bridge structures which includes the removal of all material, of whatever nature, necessary for the construction of foundations and substructures, including backfill, all in accordance with the plans or as directed by the Engineer. It shall, unless otherwise stipulated by the plans or proposal, include the furnishing of all necessary equipment and the construction of all sheeting and shoring, cribs, cofferdams, caissons, dewatering, etc., which may be necessary for the execution of the work. It shall also include the subsequent removal of these items and the placement of all necessary backfill as hereinafter specified. It shall also include the disposing of excavated material, not required for backfill, in a manner and in locations as approved by the Engineer.

The item of Cofferdam and Pumping, when specified on the plans, shall not be covered under this Section. Attention is directed to Section 503 for the requirements of this item.

215.02 Classification of Material.

Excavation for bridges shall include all material removed except water or other liquids. Excavation of material for bridges not within the classification of roadway or drainage excavation will be Unclassified Bridge Excavation.

215.03 Construction Requirements.

(a) Inspection.

1. Notification.

The Contractor shall notify the Engineer a sufficient time in advance of the beginning of the excavation for each structure, so that elevation and measurements may be taken of the existing ground. No payment will be made for material removed or excavated before these measurements have been taken.

2. Approval.

Ample opportunity shall be given the Engineer for the inspection of foundation pits and the measurement of material removed. In no case shall a foundation be closed to view until it has been inspected and approved.

3. Change in Foundation Elevations.

When in the Contractor's opinion, rock, or other firm foundation material of equal bearing value is encountered at an elevation above that shown for the footing, and at a location not subject to

erosion or scour, the Contractor shall notify the Engineer in order that he may investigate and determine if it is advisable to raise the bottom of the footing.

When the excavation for a footing has been completed to the approximate elevation shown on the plans without encountering satisfactory foundation material, the Contractor shall notify the Engineer in order that he may make an inspection and investigation, such investigation to consist of drilling, probing or jetting by the Contractor, a maximum of 4 holes per footing, each hole a maximum depth of 20 feet {6 m}. No direct payment will be made for this operation. If additional holes are required they will be paid for as provided in Article 104.03. The Engineer will then fix the proper elevation of the footing or decide upon its treatment.

4. Drilling or Probing.

When apparently satisfactory foundation material has been reached, the Contractor shall drill or probe not more than 4 exploratory holes to a maximum depth of 10 feet {3 m}. The drilling will not be required if a note is shown on the plans to waive this requirement. No direct payment will be made for this operation. If additional holes are required, they will be paid for as provided in Article 104.03.

(b) Depth and Size of Excavation.

The excavation for the bottom of the footing shall be carried to the depth as shown on the plans or as designated. The design and elevation of footings are based on soundings taken at certain points for design purposes only. These soundings may or may not be representative of the actual conditions encountered during construction. Bidders must assume the risk of having to excavate to a greater or lesser depth without altering the contract unit prices in the proposal, except as hereinafter set forth, and the footing elevations shown on the plans shall be considered as approximate only. The Engineer may order in writing such changes in dimensions or elevations of footings as may be necessary to secure satisfactory foundations for the structure.

The size of the excavation shall in all cases be ample to accommodate necessary forms down to rock, marl, Selma chalk or similar hard material suitable for embedment of footings; excavation in such materials shall be as near as possible to the neat lines of the footings and the footings poured without the use of forms. In hard materials which cannot be cut to neat lines with a pneumatic spade, line drilling along the neat lines not to exceed 9 inch {230 mm} centers will be required. In dry soils, suitable for footing embedment, capable of providing stable, neat footing lines, permission may be given to allow pouring of footings without the use of forms; otherwise, the excavation shall be sufficient for forming the foundations.

The horizontal limits of excavation shall not extend beyond what is required for sheeting, bracing, forms and reinforcing cages.

(c) Cofferdams or Sheeting and Shoring.

Cofferdams or sheeting and shoring will be required in foundation excavation work when work is adjacent to pavement, sidewalks, railroad tracks, utilities, etc., when the material encountered is unstable, when such excavation will present a hazardous or undesirable condition, or when necessitated due to water conditions. Materials and design to be used for this work will be determined by the Contractor.

Working drawings and design calculations will only be required if the foundation work is within an area adjacent to the trackline. These areas are where a railroad company will require adequately designed cofferdams, sheeting and shoring to protect the stability of the trackline during construction. The Contractor shall contact the railroad company to obtain the design requirements for the cofferdams, sheeting and shoring. Working drawings and design calculations for cofferdams, sheeting and shoring shall be submitted in accordance with the requirements given in Article 105.02.

If a seal is required in a cofferdam covered under this Section, it shall meet all of the requirements, and be measured for payment in accordance with Section 503.

(d) General Backfill.

All material used for backfill shall be soil of an acceptable quality.

All spaces excavated and not occupied by abutments, piers or other permanent work shall be backfilled. Backfill around all units of a structure shall be completed as soon as practical after the unit has obtained the required strength. Bracing, forms and rubbish shall be removed from the excavated area before backfilling is commenced.

Backfill within the limits of the roadway shall be as required by Section 210; all other backfill, except that placed below water level, shall be tamped and compacted as required by the Engineer.

(e) Foundation Backfill.

If the surface upon which the footing is to be placed becomes soft or muddy and will not dry out after the excavation has been dewatered, the Engineer may direct that a foundation course of approved free draining commercial material, as specified in Subarticle 214.02(b), be used under the footing.

If this soft and muddy condition occurred through no fault or negligence of the Contractor, the Engineer, at his discretion, may order payment to be paid under Item No. 214-B, Foundation Backfill, Commercial. If this Item is not in the contract, then payment will be made as Extra Work as specified in Article 104.03 and Article 109.04.

When the above condition was the result, in the opinion of the Engineer, of negligence on the part of the Contractor, no payment will be made for the required foundation backfill. Compaction shall be as directed by the Engineer.

(f) Preservation of Stream Banks and Channel.

The natural ground adjacent to the structure shall not be disturbed without permission of the Engineer. Unless otherwise specified, no excavation shall be made outside of caissons, cribs, cofferdams, steel piling or sheeting. The natural stream bed adjacent to the structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is permitted at the site of the structure before caissons, cribs or cofferdams, or piling are placed, the Contractor shall, without extra compensation and after the foundation is in place, backfill all such excavations to the original or established ground surface or stream bed with satisfactory material. No material or debris shall be deposited in any designated navigation channel during construction except with the approval of the Engineer. Such material or debris shall be removed to the normal navigation channel depth prior to completion and acceptance of the contract. Any material or debris resulting from the Contractor's operations deposited outside any designated navigation channel or other streams during construction except such fill as may be ordered as a permanent part of the work shall be removed and the channel freed from all obstructions before completion of the work.

(g) Disposal of Surplus and Unsuitable Material.

Surplus excavated material, after piers and abutments are backfilled, shall be used to obliterate construction scars at or near the bridge site, to smooth out depressions in and near the stream banks or as otherwise directed by the Engineer.

215.04 Method of Measurement.

(a) Unclassified Bridge Excavation.

When listed as a pay item in the contract, the quantity of Unclassified Bridge Excavation will be the number of cubic yards {meters} of material excavated, measured and calculated in its original position, subject to the following limitations:

a. The volume measured will be that actually removed (except for seal concrete footings); however, no measurement will be made for material removed outside of the area bounded by vertical planes 1 foot {300 mm} outside of the footing and parallel thereto down to hard material described in Subarticle 215.03(b) or for material excavated outside neat lines of footings in such hard material. For stepped footings the volume will be measured and computed separately for each step. When the size of a footing is reduced after the Contractor excavated for a larger footing as directed, the excavation will be measured based on the larger footing.
b. Water or other liquid will not be classed as excavated material and no measurement or direct payment will be made for their removal.
c. No measurement or payment will be made for excavation in pile abutments nor for any pile encasements.
d. No measurement or payment will be made for the excavation required for the construction of abutment caps on drilled shaft foundations.
e. No measurement will be made for material removed below the elevation designated to be the bottom of the footing, unless removal of said material is ordered. Excavation necessary and incidental to the cleaning or excavating of crevices in the floor of a foundation pit below the established footing elevation will not be measured for payment.
f. No measurement will be made for the removal of material raised by driving piles or for the removal of material that flows through or over cofferdams or caissons.
g. The measurement of the volume of excavation for a seal concrete footing shall be calculated from the following:

L = Length of footing shown on contract plans (feet {meters});

W = Width of footing shown on contract plans (feet {meters});
D = Final approved elevation of the bottom of the footing (feet {meters});
B = Average elevation of the mud line or groundline (river bottom) at the cofferdam (feet {meters});
Ve = Volume of excavation for which payment will be made (cubic yards {cubic meters}).
Ve = L x W x (B - D) / 27 {Ve = L x W x (B - D)}

Excavation outside of these limits of measurement may be required for the construction of a seal concrete footing, depending on the details of construction selected by the contractor. No direct payment will be made for any excavation outside of the footing plan dimensions shown on the contract plans.

(b) Cofferdams or Sheeting and Shoring.

Each accepted Cofferdams or Sheeting and Shoring unit will be measured for payment as a lump sum unit. A unit shall consist of all piers, bents, and abutments on a specific bridge which are not designated by the plans for Item 503-B, Cofferdam and Pumping. Partial payments will be allowed on monthly estimates in accordance with Subarticle 215.05(a)2.

215.05 Basis of Payment.

(a) Unit Price Coverage.

1. Unclassified Bridge Excavation.

Payment for the yardage of Unclassified Bridge Excavation as provided above shall be payment in full for the furnishing of all materials, equipment, tools, labor, pumping, bailing, drainage, sealing crevices, backfilling (including foundation backfill), compacting, disposal of excavated material, and for all incidentals necessary to complete the work in accordance with the plans and these specifications.

If a footing is lowered below the elevation shown on the plans, adjustments in the unit price for all of the Unclassified Bridge Excavation of the footing involved will be made as follows:

Depth Lowered Below Plan Elevation	Bid Price Plus
0 to 3 feet {1 m}	0%
Over 3 feet {1 m} to 6 feet {2 m}	50%
Over 6 feet {2 m} to 10 feet {3 m}	75%
Over 10 feet {3 m}	100%

For stepped footings, the above adjustments will be computed separately for each step.

2. Cofferdams or Sheeting and Shoring.

Payment for a lump sum unit of Cofferdams or Sheeting and Shoring as provided above shall be payment in full for the furnishing of all materials, equipment, tools, and labor necessary to complete the construction of the specified piers, bents, and abutments and the removal and disposal of any cofferdams or other temporary construction used in the prosecution of the work.

Payment for each accepted Cofferdams or Sheeting and Shoring unit will be made at the contract lump sum price bid for each unit, complete in place.

Partial payments will be made on monthly estimates based on the percentage of the total work performed on each unit as estimated by the Engineer. In making this estimate each pier or bent considered as part of a unit will be given an equal percentage of the total unit. Upon completion of the foundation above ground line at a particular pier or bent, that percentage of the total unit may be paid.

No consideration will be given for additional compensation for this item when footing elevations are lowered less than 10 feet {3 m}, such being considered incidental to the work. If elevations are lowered 10 feet {3 m} or more, consideration will be given for additional costs caused by the revised elevations in accordance with Article 109.04.

(b) Payment will be made under Item No.:

215-A Unclassified Bridge Excavation - per cubic yard { cubic meter}
215-B Cofferdams or Sheeting and Shoring, ___*___, ___**___ - per lump sum
* Station Number, Bridge Number, Ramp Number, etc.
** Lane, if applicable.

SECTION 217
SPECIAL PROTECTION FOR ROCK SLOPES

217.01 Description.

This Section shall cover the work of providing special treatments to rock slopes for protection against excessive weathering, popouts, and other detrimental conditions which may endanger the highway roadbed.

In general the following methods, used as directed by the Engineer, shall be applied to exposed rock surfaces or rock surfaces exposed by the construction.

- Rock Bolting - This work shall cover the anchoring of large blocks of rock which may be bounded by joints or cracks that might prove unstable by bolting them to more solid sections of rock.
- Seam Sealing - This work shall cover the partial removal of relatively thin seams of very soft unsatisfactory material and the resealing of the seams with a durable cap of concrete.
- Asphalt Surfacing - This work shall cover the surfacing of relatively flat horizontal sections of rock berms with an asphalt surface to prevent excessive wear or weathering of soft, unstable rock.
- Pneumatic Concrete Blanket - This work shall cover the construction of a protective blanket layer of concrete over an area of broken or loose boulders and/or unstable rock to prevent fallouts from erosion and weathering.

Special attention is directed to the fact that the items of work provided under this section are estimated and cannot be accurately determined until the work is exposed; therefore, only the amounts actually used will be measured for payment and no claims will be considered for extra compensation due to overruns or underruns of the items covered by this Section.

217.02 Materials.

(a) General.

All materials furnished for use under this Section shall conform to the applicable sections of Division 800, Materials, unless noted herein or provided on the plans.

(b) Rock Bolting.

Material fabricated for use in the rock bolting operations shall conform to the following:

1. Bolts.

a. Slotted.

All slotted bolts shall be steel conforming to the requirements of ASTM A 588, Grade A.

b. Headed.

All headed bolts shall be steel conforming to the requirements of ASTM A 588, Grade A.

2. Wedges.

All wedges shall be steel conforming to the requirements of ASTM A 588, Grade A.

3. Expansion Shells.

All expansion shells shall conform to the requirements of ASTM A 47, Specification for Malleable Iron Castings, Grade 32510. Tapered plugs used with expansion shells shall be forged from steel conforming to the requirements of ASTM A 663 and A 675, Grade 60 to 65.

4. Roof Plates.

All roof plates shall be steel conforming to the requirements of ASTM A 242, Type 2, or ASTM A 588, Grade A.

217.03 Construction Details.

(a) Rock Bolting.

1. General.

Rock bolts shall be installed at the direction of the Engineer at any point where the stability of the rock cut is questionable. When bolting is deemed desirable, it shall be done as quickly as possible. Rocks should be kept tight and not pulled back into place once it has been loosened by successive blasting or construction operations. The holes for the rock bolts shall be drilled as closely as possible to the diameter recommended by the manufacturer of the wedge or shell.

2. Torque.

The diameter and length of the rock bolt to be used shall be determined by the Engineer. All installations shall be in accordance with the recommended procedure or method as given by the manufacturer of the rock bolts. When directed by the Engineer, proper tests will be made to determine what torque the rock can withstand. If the tests show that the highest torque practical is of a certain value for a particular grade of rock, then torque shall be applied to the rock bolt provided the torque does not exceed the maximum recommended by the manufacturer of the rock bolts. It is recognized that any over-application of torque will only destroy the anchorage in the rock and in due time destroy the initial tightness of the bolt. It is desired that a minimum torque of 125 foot pounds {170 N•m} be applied in all cases where the rock will withstand such pressure.

3. Installation Details.

Extreme care shall be taken to keep the drill hole aligned perpendicular to the plate bearing surface. The diameter of the drill hole shall be as recommended by the manufacturer for the type of expansion unit to be used for anchorage into the rock. Expansion units shall not be used in holes larger than that for which they are designed. When slotted type rock bolts are used, the bolt with wedge shall be inserted in the hole until the wedge hits the bottom of the hole. The bolt shall then be driven into the hole with an air-percussion hammer forcing the wedge into the slotted end of the bolt, thus anchoring the bolt in the hole. The plate and nut shall then be installed on the collar end of the bolt and the nut tightened to the torque recommended by the manufacturer.

(b) Seam Sealing.

1. General.

The seam designated by the Engineer for sealing shall be examined carefully during the grading operations for evidence of seepage which will require construction of weep holes in the sealing cap as well as for the best method for placing the sealing cap.

2. Cleaning of the Seam.

The material in the seam to be treated shall be routed out or otherwise removed to a depth at least equal to the thickness of the seam or layer to be treated or to a depth which will give firm support to the sealing material.

3. Sealing the Seam,

The clean seam shall be sealed or packed with one of the following types of concrete mixes. The method of packing or placing the sealant shall be left to the Contractor provided the method used produces the desired results and presents an acceptable appearance. Weep holes, when deemed necessary, shall be placed as directed.

a. Low Slump - Class A concrete as provided by Section 501 of the Standard Specifications.
b. Pneumatic Concrete of an approved mix of cement, additives, aggregates, and water applied pneumatically. (Mix designed by the Contractor to produce a 28 day cylinder strength of 5000 psi {35 Mpa})
c. Retempered - Class A concrete.

(c) Asphalt Surfacing.

1. General.

An Asphalt Surface shall be placed on areas designated by the Engineer to prevent excessive erosion from surface runoff over relatively soft and erodible materials.

2. Preparation of Surface.

The surface to receive the asphalt surfacing shall be fairly uniform, without excessive high and low spots, suitable for coverage with asphalt. The surface shall be clean and free from loose rock fragments before applying the surfacing material.

3. Surfacing Material.

The surfacing material shall be Asphalt Cement Grade 40 or an approved equal. The bituminous material shall be applied at the rate of 1.25 gallons per square yard {5 L/m^2}. The method of application shall be that of the Contractor's provided it is approved by the Engineer and it produces the desired results and presents a pleasing appearance.

(d) Pneumatic Concrete Blanket.

1. General.

The exposed surface designated by the Engineer to receive this type treatment shall be carefully examined to determine the installation procedure which will be necessary to conform to the reinforcing details shown on the plans.

2. Cleaning the Area to be Treated.

The area to be treated shall be cleaned of all loose scaly rock or soil fragments by the use of pressurized water and air jets or other approved means as directed by the Engineer.

3. Placement of the Protective Blanket.

a. Reinforcement shall be placed in accordance with the details shown on the plans or as directed. Anchorage of the reinforcement to the slope shall be accomplished by the use of the anchor bolts of the size and shape shown by plan details.

b. The pneumatic concrete blanket shall consist of an approved mix of cement, additives, aggregates, and water pneumatically applied to the surface to be treated. (The mix shall be designed by the Contractor so as to produce a 28 day cylinder strength of 5000 psi {35 Mpa}). Placement of the pneumatic concrete shall be in accordance with the supplying producer's recommendations, provided the method used produces the desired results and presents an acceptable appearance. (Note - It is not the intent of this specification to require a uniform surface, but to provide a fairly uniform layer of concrete of not less than the depth shown on the plans, which in general parallels the surface being treated.)

217.04 Method of Measurement.

(a) Rock Bolting.

The measurement for rock bolts will be the linear feet {meter} of the specific size designated by the Engineer, complete in place and accepted.

(b) Seam Sealant.

The seam sealing material will be measured in cubic yards {cubic meters}, complete in place. The volume of material actually placed will be computed from measurements of the actual length, width, and depth of the excavated seam opening. No allowance will be made for the replacing of material removed beyond the depth directed.

(c) Asphalt Surfacing.

The Asphalt Surfacing material will be measured in gallons {liters}.

(d) Pneumatic Concrete Blanket.

The measurement of the Pneumatic Concrete Blanket will be measured in square yards {square meters}, computed from the areas actually ordered treated. No allowances will be made for material placed outside of the designated areas nor for crevices, etc., required to be filled in order to obtain a continuous blanket over the area.

217.05 Basis of Payment.

(a) Unit Price Coverage.

1. Rock Bolting.

The accepted length of rock bolts placed as directed will be paid for at the contract price per linear foot {meter}, complete in place, which price shall be full compensation for furnishing and installing all materials, including bolts, wedges, expansion shells, and accessories and for all equipment, tools, labor, and incidentals necessary to complete the work.

2. Seam Sealant.

The accepted volume of seam sealant, measured as noted above, will be paid for at the contract unit price bid for the seam sealant which shall be payment in full for the item complete in place and shall include all excavation, disposal of excavation, materials, furnishing of the sealant, placing of the sealant, and for all equipment, tools, labor, and incidentals necessary to complete the work.

3. Asphalt Surfacing.

The accepted volume of asphalt surfacing placed as directed will be paid for at the contract unit price bid per gallon {liter} which shall be payment in full for the bituminous material complete in place and includes furnishing the bituminous material, preparing the surface, transporting and heating

of the material as required, placing the material in the areas designated, and for all equipment, tools, labor, and incidentals necessary to complete the work.

4. Pneumatic Concrete Blanket.

The accepted area treated under this item will be paid for at the contract unit price bid per square yard {square meter} which shall be payment in full for the pneumatic concrete blanket complete in place and includes preparation of the surface to be treated, furnishing all materials, installation of wire reinforcement, its accessories and anchor bolts, placement of the pneumatic concrete, and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

217-A Rock Bolting, 1" {25 mm} Slotted - per linear foot {meter}
217-B Rock Bolting, 5/8" {16 mm} Headed - per linear foot {meter}
217-C Rock Bolting, 3/4" {19 mm} Headed - per linear foot {meter}
217-D Rock Bolting, 7/8" {22 mm} Headed - per linear foot {meter}
217-E Seam Sealant - per cubic yard {cubic meter}
217-F Asphalt Surfacing - per gallon {liter}
217-G Pneumatic Concrete Blanket, ___ inches {mm} thick - per square yard {square meter}

SECTION 219
LANDSLIDE CORRECTIONS

219.01 Description.

This Section shall cover the work of correcting a landslide in an existing roadway slope within the designated areas shown on the plans or directed by the Engineer, all in accordance with the details shown on the plans or noted in this provision.

219.02 Materials.

Materials furnished for use shall conform to the appropriate requirements of the Standard Specifications for the type work performed or noted herein.

(a) Geotextile Filter.

A geotextile to be used as a special underdrain shall meet the requirements of plan details, AASHTO M 288 for Subsurface Drainage Geotextile, Class 2, and Section 810 of these specifications. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

(b) Horizontal Drainage Pipe.

The drainage pipe shall be PVC, Schedule 80, Type I or II, or Schedule 120 conforming to the requirements given in ASTM D 1785. The I.D. of the pipe shall be 1.5 inches {38 mm} unless noted otherwise on the plans.

The pipe shall be furnished in lengths suitable for use with the drilling equipment approved for use.

The ends of the pipe shall be machined to provide a smooth wall slip coupling when joined using appropriate solvent welding material thus precluding the use of conventional slip couplings. Fittings necessary for the outfall connections outside the drilling limits shall be PVC, Schedule 80, Type I or II, or Schedule 120 fittings having a burst strength equal to or greater than the pipe noted herein. All pipe and fitting connections shall utilize solvent weld joints.

Slotted pipe shall be furnished unless noted otherwise on the plans. Slotted pipe shall have two rows of slots circumferentially cut 120 degrees apart. The average configuration shall be 46 slots per row, per foot {300 mm} with a maximum 0.010 inch {0.25 mm} slot opening when used in a silty or clay soil or 42 slots per row, per foot {300 mm} with a maximum 0.050 inch {1.3 mm} slot opening when used in a granular material. The configuration and the slot opening size shall be as shown on the plans.

(c) Rock Buttress Material.

Unless otherwise noted on the plans, rock buttress material shall be sandstone, limestone, dolomite, or granite free of dirt and debris. Rock buttress material shall have the physical properties for soundness, wear resistance and limited deleterious material content given in Section 814 for riprap.

No more than 10 % of the rocks used for the main buttress construction shall have a weight over 500 pounds. At least 50 % shall have a weight over 80 pounds. No more than 10 % shall have a weight under 10 pounds. Oversize rocks may be allowed by the Engineer if spaced to permit filling and densification of the buttress.

Rock used for choking shall pass a 4 inch {100 mm} screen and shall be no more than 10 % of the total rock required for the buttress.

Acceptance of the gradation will be by visual inspection by the Engineer at either the source of the rock or at the project site. Any difference of opinion between the Engineer and the Contractor about the acceptability of the gradation shall be resolved by sampling and testing the rock in accordance with the method provided in ALDOT-239. The equipment, labor and sorting site for this procedure shall be provided by the Contractor at no cost to the Department.

219.03 Construction Requirements.

(a) General.

In general, the work necessary to correct a landslide is dependent upon the in situ conditions and extent of damage existing at each site and will vary according to the details shown on the plans.

Basic procedures may require any combination of the following work items:

1. Excavation for the removal of loose or unwanted material. Normally, Unclassified Excavation as provided in Section 210 will apply unless otherwise noted by plan details.
2. Construction of paved flumes, installation of underdrain systems (Standard Underdrain as provided in Section 606 or Special Underdrain as noted herein or detailed in the plans), or other methods of removing surface or ground water from the area.
3. Construction of retaining structures (Standard Retaining Wall, Mechanically Stabilized Earth Wall, or Rock Buttress) as noted by plan details to stop slippage of slope material.
4. Restoration of back slope or front slope to a designated slope angle utilizing removed material, ordinary or special borrow material as designated by the plans. This work requires the preparation of the surface by rolling or otherwise compacting the area as directed to receive the backfill material. The backfill material shall be placed in the same manner as prescribed in Subarticle 210.03(d) for embankment.
5. Restoration of the erosion control over the repaired area as prescribed by the appropriate erosion control items provided in the contract.

(b) Excavation.

The area designated for treatment shall be excavated to the depth indicated by the plans or directed to remove loose or otherwise unacceptable material. Removed material designated for re-use shall be stockpiled on approved areas; material not designated for re-use shall be disposed of as required in Article 210.05. Unless stockpile areas are designated on plan details, the Contractor shall provide, at his expense, satisfactory storage areas outside of the right of way limits.

(c) Drainage Systems.

1. Surface drainage systems, when required, will be classified, paid for, and constructed under the appropriate item for such provided in the contract (reference Sections 610, 614, 615, 616, and 654).

2. Underdrain systems, when required, will be one of the following classifications as indicated by the plan details.

a. Standard underdrain - constructed and paid for under the provisions of Section 606.
b. Special underdrains - constructed in accordance with the details provided in the plans for size, shape, and content.
c. Special Filter Blanket - constructed in accordance with the details provided in the plans, specifications, or as directed by the Engineer for size, shape, content, and type. If an aggregate blanket is required, the type and size of aggregate shall be as designated on the plans. The geotextile filter shall be placed in the manner and at the locations shown in the plans or as directed by the Engineer. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any geotextile damaged during its installation or during placement of backfill material shall be replaced by the Contractor at no additional cost to the State. The work shall be scheduled so that 14 days

does not expire between placement of the geotextile and the covering of the geotextile with backfill. Backfill aggregate shall not be dropped on the geotextile from a height greater than 1 foot {300 mm}. Greater drop heights will be permitted if the Contractor provides a cushioning layer of sand on top of the geotextile before dumping of any stone. The combination of drop height for stone and sand cushion layer thickness to be approved must be demonstrated to not puncture or damage the geotextile. No measurement or separate payment shall be made for a sand cushion layer placed for the purpose of allowing an increased drop height of stone. Any damage to the geotextile during placement of aggregate shall be corrected prior to proceeding with the work.

d. Horizontal Drains - constructed in accordance with the following details at locations, etc. shown on the plans or directed.

(1) Horizontal drains shall cover the work of drilling appropriate size horizontal holes (angle and slope designated on plans) into backslope or frontslope and the installation of a designated size of slotted PVC drainage pipe to facilitate drainage of ground water.

(2) The installation procedure requires the holes be drilled with rotary drilling equipment capable of providing 3 inch {75 mm} to six inch {150 mm} diameter holes up to 600 feet {180 m} in length to the designated lines and grades through soil and rock formations.

(3) The drilling equipment shall allow the installation operation to be accomplished by inserting the plastic drain inside the drill hole the full length of the drill hole.

(4) The installation operation of the drain pipe shall be done in such a manner that the drain pipe will be cemented together where necessary to form a continuous tube and will not be telescoped or damaged to the extent that its drainage efficiency will be impaired when completed.

(5) The entrance end of the pipe shall be plugged with a rounded or pointed extension. The space between the drilled hole and the pipe shall be tightly plugged with earth for a length of at least 2 feet {600 mm} at the outlet end of the hole.

(6) Water used for drilling and water developed during drilling operations shall be disposed of by the Contractor in such a manner that no damage will result to the work.

(7) Unslotted PVC pipe approximately 10 feet {3 m} in length, shall be provided at the mouth of the drain to collector structure.

(d) Slope Retaining Structures.

1. Retaining walls (cast-in-place or precast), if required, shall be constructed, measured, and paid for as provided in the appropriate Section of the Specifications.

2. Rock buttress, if required, shall be constructed, etc., in accordance with the following requirements:

a. General.

The construction, in general, consists of the excavation of a trench, preparation of a bedding to receive a rock buttress and the construction of a rock buttress to the line, grades, and slopes detailed on the plans.

b. Excavation of Trench.

The excavation necessary to prepare the trench to the line, grades, slopes, and section shown on the plans or directed shall be classified and paid for under the Item of Unclassified Excavation or as provided on the plans.

c. Preparation of Trench Bed.

The preparation of the trench bed shall be as detailed on the plans. Special bedding, if required, will be noted on the plans. Materials used in the special bedding shall conform to the specified sections of the Standard Specifications and will be paid for under the appropriate pay item for the materials used.

d. Rock Buttress.

The rock buttress shall be placed in the prepared trench to the slopes shown on the plans or directed by the Engineer. Choking material shall be provided when needed to sufficiently fill the voids to allow for traversing by truck or as a filter layer between the rock buttress and any required

embankment materials. Densification of the rock backfill will be required as directed by the Engineer but density testing will not be required.

Furnishing of the rock for the construction of the buttress shall be the responsibility of the Contractor. If permission is given to use any material outside regular excavation limits within the right of way, it will be paid for only once under the appropriate pay item provided by this Section.

(e) Construction Requirements for Geotextiles.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

The geotextile shall be placed and anchored on a smooth graded surface approved by the Engineer. The geotextile shall be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the geotextile. Anchoring of the terminal ends of the geotextiles shall be accomplished through the use of key trenches or aprons at the crest and toe of the back slope of the buttress or as specified on the plans.

Successive geotextile sheets shall be overlapped in such a manner that the upslope sheet is placed over the downslope sheet or upstream over downstream. In underwater applications, the geotextile and required thickness of backfill material shall be placed the same day. The backfill placement shall begin at the toe and proceed up the slope.

Riprap and heavy stone filling shall not be dropped onto the geotextile from the height of more than 1 foot {300 mm}. Smaller sizes of stone filling shall not be dropped onto the geotextile from a height exceeding 3 feet {1 m}. Any geotextile damaged during placement shall be replaced as directed by the Engineer at no additional cost to the State.

The geotextile shall be joined by either sewing or overlapping as outlined in Article 608.05 of these specifications. All seams shall be subject to the approval of the Engineer. Overlapped seams shall have a minimum overlap of 12 inches {300 mm} except where placed under water where the overlap shall be a minimum of 3 feet {1 m}.

A geotextile patch placed over a damaged area shall be extended 3 feet {1 m} beyond the perimeter of the tear or damage.

(f) Restoration of Slide Slope.

Restoration of slide slope (front or back) shall consist of preparing the area to receive the replacement material by the shaping and compaction of the area as prescribed in Subarticle 210.03(d) for embankments. The material in place shall be compacted as noted in the plan details or directed by the Engineer.

The backfill material may be the material previously removed, ordinary borrow, or special backfill material of the type designated in the plans or proposal. Said backfill shall be placed in layers and compacted as prescribed in Section 210 or noted by plan details.

Erosion control items provided in the plans shall be used to re-establish the ground cover damaged or destroyed by the landslide or the restoration work.

219.04 Method of Measurement.

(a) General Item.

Construction items not specifically provided in this Section will be classified, measured, and paid for under the respective pay items for such work provided in the contract.

(b) Rock Buttress for Landslide Correction.

The Item of Rock Buttress for Landslide Correction, when provided in the plans or proposal, will be the weight {mass} of rock used in construction of the buttress, measured on approved scales.

Measurement of any special bedding, if required, will be as specified for the respective pay item used for bedding.

(c) Special Underdrain.

The Item of Special Underdrain, when provided in the contract, will be measured in linear feet {meters} of each special type detailed in the plans, along the center of each line or lateral, center to center of junctions and/or fittings.

(d) Special Filter Blanket.

The Item of Special Filter Blanket, when provided in the contract, will be measured in square yards {square meters} to the nearest 0.1 square yard {0.1 m^2}, complete in place, for the material placed and accepted.

(e) Horizontal Drains.

Horizontal drains will be measured by the linear foot {meter} of drain pipe installed in the holes drilled, including the extension necessary to discharge into the collector structure.

(f) Special Backfill for Slide Correction.

1. When the item of special backfill for slide correction per ton {metric ton} is provided in the contract, the material ordered and accepted will be measured in tons {metric tons} on approved scales.

2. When the item of special backfill for slide correction per cubic yard in place {cubic meter} is provided in the contract, the accepted volume of backfill will be measured in cubic yards {cubic meters} complete in place by the cross section and average end area method. Cross sections shall be taken of the material in its original position, whether from a borrow pit, stockpile, or other approved source, before placing of the backfill and re-cross sectioned after placing the backfill. The volume computed between these cross sections shall be the volume of backfill.

219.05 Basis of Payment.

(a) Unit Price Coverage.

1. When the Item of Rock Buttress for Landslide Correction is provided in the plans or proposal, the accepted weight {mass}, measured as noted above, will be paid for at the contract unit price bid. Said contract unit price bid shall be payment in full for furnishing and/or producing material, royalties, loading, hauling, placing, consolidating, shaping, and for all equipment, tools, labor, and incidentals necessary to complete the work.

2. The accepted Item of Special Underdrain, measured as noted above, will be paid for at the contract unit price bid per linear foot {meter}, which shall be full compensation for the underdrain complete in place. Said unit price includes excavation of the trench, backfill and compaction thereof, furnishing and installation of any pipe, fittings, geotextile filter, or filler necessary thereto, furnishing and placing of a connection to an outfall pipe or collector structure, the disposal of excess material, and for all tools, equipment, labor, and incidentals necessary to complete this item of work.

3. The accepted Item of Special Filter Blanket, measured as noted above, will be paid for at the contract unit price bid per square yard {square meter}, which shall be full compensation for the item complete in place and includes the furnishing of all materials, preparation of the area to receive the filter blanket, installation of the blanket and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

4. The accepted Item of Horizontal Drain, measured as noted above, will be paid for at the contract unit price per linear foot {meter}, which shall be full compensation for furnishing and installation of the drains complete in place and connected to the collector structure. Said unit price includes full compensation for furnishing all materials, services, equipment, tools, labor, and incidentals necessary to complete this item of work.

5. The Items of Special Backfill for Landslide Correction, ordered, accepted, and measured as noted above, will be paid for at the appropriate unit price bid per ton {metric ton} or cubic yard {cubic meter}, complete in place, which shall be full compensation for the furnishing of the type material designated for preparation of the area to be treated, loading, hauling, placement, compaction, and dressing of the area to the designated slope and includes all equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

219-A Rock Buttress for Landslide Correction - per ton {metric ton}
219-B Special Underdrain ___ inch {mm} Diameter - per linear foot {meter}
219-C Special Filter Blanket __*_ - per square yard {square meter}
219-D Horizontal Drain ___ inch {mm} Diameter - per linear foot {meter}
219-E Special Backfill for Landslide Correction - per ton {metric ton}
219-F Special Backfill for Landslide Correction - per cubic yard {cubic meter}

* Specify either Aggregate or Geotextile.

SECTION 224
TREATMENT OF LIME SINKS

224.01 Description.

The work under this Section shall cover the treatment required to correct conditions occurring when lime sinks are found within or adjacent to construction limits of the work. The application and extent of the treatment will be in accordance with plan details or as directed.

224.02 Materials.

Material furnished for use under this Section shall be of the quality and character noted on the plans or ordered by the Engineer, suitable for the purpose intended, and consistent with the requirements for such materials as may be noted in other parts of these Specifications.

224.03 Construction Requirements.

(a) General.

Choice of equipment to perform the work required under this Section shall in general be that of the Contractor provided such will produce the desired results within the limits directed by the Engineer.

(b) Sequence of Work.

To properly evaluate the limits of the corrective treatment required to effectively bridge a lime sink, the work shall be performed in the following sequence:

1. Exploration of the lime sink area to locate the sink hole will be as directed by the Engineer; the size of the exploratory excavation shall be kept to a minimum.
2. The sink hole, once located, shall be enlarged to the size and depth as directed by the Engineer to expose the solution cavity.
3. After exposing the solution cavity, it shall be plugged with a rock boulder or a plug of suitable material capable of sealing the cavity, yet maintaining proper ground water drainage.
4. After installation of the plug, a strata of selected material that will permit proper ground water drainage shall be placed to a depth of approximately one-half the excavated hole depth, but not in excess of 7 feet {2 m}. The material used for this "Special Backfill" shall be of the type shown on the plans or directed. This special backfill material shall be placed in approximately equal uniform layers, not to exceed 2 feet {600 mm} in thickness, for the depth specified or directed. No compaction or density tests will be required.
5. The remainder of the backfill for the lime sink excavation shall then be constructed of Unclassified Excavation, Borrow, or other designated material in accordance with the requirements for Embankments as required in Section 210.
6. In the event a sink hole occurs in the immediate vicinity of the finished subgrade elevation, the use of concrete seal may be directed. In such case the same process noted before shall be used up to the bottom elevation designated for the concrete seal. The concrete shall be Class A concrete of the thickness shown on the plans or as directed. Steel reinforcement, if required, will be as provided by the plans or as directed.

224.04 Method of Measurement.

(a) Lime Sink Excavation.

Measurement for this item will be in cubic yards {cubic meters} computed from field measurements of the material actually removed as directed.

(b) Special Backfill for Lime Sink.

Special backfill material, furnished as directed, will be measured in cubic yards {cubic meters}, loose measurement, or per ton {metric ton} in the transporting vehicle. The boulder or plug will be measured for payment as an estimated number of cubic yards {cubic meters} or an estimated tonnage {metric tonnage}.

(c) Concrete Seal.

When the use of a concrete seal is ordered, measurement will be made in cubic yards {cubic meters} computed from field measurement of concrete actually placed. All reinforcement required will be measured in accordance with Section 502, Steel Reinforcement.

224.05 Basis of Payment.

(a) Unit Price Coverage.

1. The accepted volume of Lime Sink Excavation, measured as provided above, will be paid for at the contract unit price bid which shall be payment in full for the removal and disposal of the excavated material in a manner satisfactory to the Engineer, and for all equipment, tools, labor, and incidentals necessary to complete the work in accordance with the plans and this Specification.

2. The accepted volume of Special Backfill material, including the plug, measured as noted above in accordance with the method provided in the contract (cubic yard {cubic meter} or ton {metric ton}), will be paid for at the contract unit price bid which shall be payment in full for the item complete in place and shall include all costs incidental to procurement, excavating, hauling, dumping, spreading, and formation of the embankment and for all equipment, tools, labor, and incidentals necessary to complete the work in accordance with the plans and these Specifications.

3. The accepted volume of concrete for the seal, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the preparation of the concrete bed, furnishing of all materials, mixing, hauling and placing, and for all labor, tools, equipment, and incidentals necessary to complete the item. Steel reinforcement will be paid for under Item 502, Steel Reinforcement.

(b) Payment will be made under Item No.:

224-A Lime Sink Excavation - per cubic yard {cubic meter}
224-B Special Backfill for Lime Sink, Type Material - per cubic yard {cubic meter}
224-C Special Backfill for Lime Sink, Type Material - per ton {metric ton}
224-D Concrete Seal for Lime Sink - per cubic yard {cubic meter}

SECTION 230
ROADBED PROCESSING

230.01 Description.

This Section shall cover the operations required to provide a satisfactory roadbed for receiving a base or pavement structure layer. Roadbeds will be of two types: (1) Improved Roadbeds when designated on the plans or (2) Modified Roadbed whenever Improved Roadbed is not specified on the plans. This Section covers the additional work above that required for regular earthwork construction specified under Section 210.

Improved Roadbed. Improved roadbed shall require the top layer, or layers, of the graded earth of both cuts and fills, with the upper surface at subgrade elevation, to be constructed of selected material from Unclassified Excavation or Borrow. Each layer of the plan designated thickness shall be processed and compacted as specified in Article 230.03.

Modified Roadbed. Modified roadbed shall require that the existing top layer of the graded earth of both cuts and fills below subgrade elevation be processed and compacted as specified in Article 230.03. This procedure is to establish a proper subgrade before constructing an overlying layer.

230.02 Materials.

(a) Improved Roadbed Materials from Unclassifed Excavation.

Materials for Improved Roadbed that are from Unclassified Excavation shall be the best available materials, as determined by the Engineer, meeting the requirements given in Item 210.02(c)2.

(b) Improved Roadbed Materials from Borrow Excavation.

Materials for Improved Roadbed that are from Borrow Excavation shall meet the requirements given in Item 210.02(c)2.

230.03 Construction Requirements.

(a) General.

Choice of equipment to perform the work required under this Section shall, in general, be that of the Contractor, provided such produces the desired results.

Construction of the roadbed shall be conducted so that earth or other material does not prevent immediate drainage of water to the side ditches.

(b) Improved Roadbed.

1. Preparation of Roadbed.

Both cuts and fills shall be graded to the elevation designated on the plans, below subgrade elevation in accordance with the requirements of Section 210, and to the Typical Section shown on the plans or directed. No selected roadbed material shall be placed until the graded earth surface is satisfactory to grade, cross section, and density in accordance with Section 210. If a contract requires an improved roadbed to be placed on an earth surface constructed under a previous contract, the surface shall be repaired to the extent directed. Additional material required will be paid for under the proper classification of the material directed to be used.

2. Placement and Processing of Selected Roadbed Material.

After preparation as noted above, the roadbed shall be brought up to subgrade elevation in maximum 6 inch {150 mm} layers using the designated selected materials. Each of these layers, except those specified in this Subarticle, shall be processed, utilizing the item Roadbed Processing, by thoroughly pulverizing, blending, and mixing until uniform in texture and appearance, insofar as practical, as determined by the Engineer. Each layer shall be compacted to the density noted in Subarticle 230.03(d) for improved roadbed layers. The section and density shall be maintained until placement of the next overlying improved roadbed, subbase, base, or other layer.

3. Special Conditions.

In grading contracts which do not provide a subbase, base, or other overlying layer, the upper improved roadbed layer will not be processed as outlined above for Roadbed Processing, but shall be brought to the required elevation, typical section, and density, that specified in Subarticle 230.03(d). The required section shall be maintained until final acceptance; however, maintenance of the density will not be required.

(c) Modified Roadbed.

1. Preparation of Roadbed.

The graded earth shall have been constructed to subgrade elevation in accordance with Section 210 or may, by previous contract, have been constructed as an improved roadbed. No roadbed shall be processed, as outlined in this Subarticle, until the graded earth surface is satisfactory to elevation and typical section. If a contract requires roadbed processing on an earth surface constructed under a previous contract, the surface shall be repaired to the extent directed. Additional material required will be paid for under the proper classification of the material directed to be used.

2. Processing of the Roadbed Material.

After preparation as noted above, the top six inch {150 mm}, minimum, layer, except for those layers specified in this Subarticle, of the entire width of both cuts and fills shall be processed, utilizing the item Roadbed Processing, by thoroughly pulverizing, blending, and mixing until uniform in texture and appearance, insofar as practical, as determined by the Engineer. Each layer shall be compacted to the density noted in Subarticle 230.03(d) for modified roadbed. The section and density shall be maintained until placement of the next overlying subbase, base, or other layer.

3. Special Conditions.

The work described for a modified roadbed is for the establishment of a proper subgrade before constructing an overlying subbase, base, or pavement layer or temporary surfacing. In grading contracts which do not provide for one of the above, the upper 6 inch {150 mm} layer of subgrade will not be processed as outlined above for Roadbed Processing, but shall be brought to the required elevation, typical section, and density, that specified in Section 210. The required section shall be maintained until final acceptance; however, maintenance of the density will not be required.

In addition to the above, Roadbed Processing will not be required for those roadbeds which are to be stabilized as specified in Section 231 or Section 232.

(d) Density Requirements.

Density for the layers of both improved and modified roadbed shall be as specified in Section 306 for each type layer.

(e) Surface Requirements.

The graded earth surface and the finished subgrade surface, after being properly compacted, shall be checked by the use of blue-tops, strings, and template and all portions not within the following tolerances shall be corrected: Variations from the designated grade up to plus 1/2 inch {13 mm} or minus 1 inch {25 mm} will be allowed provided the variation does not increase or decrease more than

1/2 inch {13 mm} in 100 feet {40 m}; however, at bridge structures a plus tolerance will require additional fine grading to prepare a suitable grade tie. The finished surface shall not vary at any point more than 1/2 inch {13 mm} in any 25 foot {7.5 m} section from a taut string applied parallel to the surface and the roadbed centerline, or more than 1/2 inch {13 mm} from a template placed at right angles to the roadbed centerline. The template shall be of a rigid frame, adjustable metal type, accurately set, and at least as long as the width of roadbed being checked up to 30 feet {9 m}. Additional widths may be checked by the use of string and level. The Contractor shall furnish template, string, and necessary personnel to handle same under the direction of the Engineer. No subbase or other layer shall be placed on the roadbed until it meets specified requirements for alignment, grades, cross section, and density.

Where a Permeable Asphalt Treated Base (PATB) layer is to be placed (Pay Item 327-E), the finished subgrade elevations shall not vary from design by more than 0.03 feet {10mm} based on rod and level survey readings taken at a minimum of five locations across each lane (edge, outer wheel path, midlane, inner wheel path, and inside edge of lane) at longitudinal intervals not greater than 50 feet {15 m}. Surface irregularities shall not exceed 1/4 inch {7 mm} between two points longitudinally or transversely using a 10-foot {3 m} straightedge.

(f) Protection and Maintenance of Roadbed.

The Contractor shall be responsible for the protection and maintenance of any existing roadbed or any roadbed constructed during the contract. The roadbed shall be maintained free from ruts and other depressions, in a smooth and compacted condition, and true to lines and grades. Any of the Contractor's hauling and other equipment used in such a way as to cause excessive rutting or raveling of the roadbed material shall either be removed from the work or suitable runways shall be provided to prevent rutting.

No payment will be made for the protection and maintenance of the roadbed, such being considered incidental to the work. However, if a contract requires an improved roadbed to be placed on an earth surface constructed under a previous contract, the surface shall be repaired to the extent directed under the requirements of Section 210.

230.04 Method of Measurement.

Measurement and payment for the materials used in the construction of improved roadbed and modified roadbed will be at the contract unit price for unclassified or Borrow Excavation as provided in the contract.

Measurement for the Item of Roadbed Processing (which is the additional processing over and above that normally required by Section 210) will be in 100 foot {100 m} roadbed stations for each layer processed.

The length of roadbed stationing will be in 100 foot {100 m} stations and fractions thereof to the nearest foot {meter} of any main roadbed in accordance with the following: on each roadbed separately for divided highways having more than one roadbed; on each half of a roadbed of a four lane facility constructed with a positive divider between opposing traffic; on ramps; on frontage, connecting, and crossing roads; and on widening work each roadbed as defined above whether widening is on one side or both sides. No measurement will be made for increased widths, lanes, turnouts, spurs, or crossovers when shown on the plans or for variations in widths due to changes in slopes. For additional areas over those shown on the plans, measurement will be allowed in the ratio of the increase in width to the standard width shown on the plans. The total measurement shall be the sum of the lengths measured along the center of the main roadbed or along each separate roadbed of divided highways, plus the measured ramps from where the ramp centerline crosses the edge of shoulders, plus (if any) the lengths of cross roads, connecting roads, and frontage roads. The length of modified roadbed or improved roadbed constructed under a previous contract and actually reprocessed will be measured for payment.

No separate measurement will be made for reshaping of a roadbed constructed under a previous contract, such being considered incidental to the work covered by this Section; however, any additional material required to restore the roadbed to typical section will be measured and paid for under the appropriate item of material ordered used.

230.05 Basis of Payment.

(a) Unit Price Coverage.

Each separate layer of roadbed processed and accepted, and measured as noted above, will be paid for at the unit price bid for 100 foot {100 m} roadbed stations. Said unit price bid shall be full compensation for the mixing, remixing, watering, and re-processing necessary to obtain and maintain

the required grade, section, and density as noted herein in this Section and includes all equipment, tools, labor, and incidentals necessary to complete the work as described herein.

(b) Payment will be made under Item No.:

230-A Roadbed Processing - per Roadbed Station

SECTION 231
STABILIZED ROADBED

231.01 Description.

This Section shall cover the work of preparing a roadbed for receiving a base and pavement structure by stabilizing it with an approved local or commercial material. The work shall consist of scarifying the roadbed, incorporating the stabilizing material into the roadbed, and compacting the roadbed to the proper grade, section, and density.

When stabilizing material is present on the roadway surface, the work shall consist of incorporating the stabilizing aggregate into the roadbed and compacting the roadbed surface to the proper grade, section, and density.

231.02 Materials.

The stabilizing material to be incorporated shall be an approved local or commercial material of the type provided by the plans or proposal,

231.03 Construction Requirements.

(a) General.

Choice of equipment to perform the work under this Section shall, in general, be that of the Contractor provided such produces the desired results noted herein and does not damage or injure any completed work or facility designated to be incorporated into the work.

(b) Preparation of the Roadbed.

The roadbed shall have been prepared in accordance with the provisions of Section 210. The designated sections of the roadbed of the width specified on the plans of both cuts and fills shall then be scarified or otherwise loosened for the depth specified by the plans or as directed. Certain equipment capable of mixing the stabilizing material and the material in place without pre-working the in-place material may permit combining this step with the requirements of Subarticle (c) below.

(c) Placement and Processing of Stabilizing Material.

The approved stabilizing material shall be spread uniformly over the roadbed, at the rate specified on the plans or as directed, by approved spreading equipment.

The stabilizing material shall then be mixed with the subgrade material until uniform in color and texture as directed and compacted to the required grade, section, and density.

(d) Density and Surface Requirement.

Density and surface requirements shall be the same as specified in Subarticle 230.03(d) and (e), respectively.

(e) Protection and Maintenance of Roadbed.

Protection and maintenance of roadbed shall be the same as specified in Subarticle 230.03(f).

231.04 Method of Measurement.

All accepted stabilizing material ordered and accepted will be measured in cubic yards {cubic meters}, loose measurement, or per ton {metric ton}.

Stabilizing Roadbed with In-Place Material will be measured in units of Roadbed Station as described in Article 230.04.

231.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted volume of Roadbed Stabilizing Material, measured as noted above in accordance with the method provided in the contract (cubic yard {cubic meter} or ton {metric ton}), will be paid for at the contract unit price bid which shall be full compensation for the item complete in place on the roadbed. Said unit price shall include all cost of procurement, hauling, spreading, scarifying,

mixing, and processing as required to incorporate the stabilizing material to the specified depth, to obtain and maintain the required grade, section, and density of the roadbed until covered by an overlying layer of ordered material and includes all equipment, tools, labor, and incidentals necessary to complete the work.

The contract unit price for Stabilizing Roadbed with In-Place Material, shall be full compensation for all equipment, tools, labor, and incidentals required for mixing, and processing, as required to incorporate the stabilizing material to the specified depth. It shall also be full compensation for obtaining and maintaining the required grade, section, and density of the roadbed until covered by an overlying layer.

(b) Payment will be made under Item No.:

231-A Roadbed Stabilizing Material, Type Material - per cubic yard {cubic meter}
231-B Roadbed Stabilizing Material, Type Material - per ton {metric ton}
231-C Stabilizing Roadbed with In-Place Material per Roadbed Station

SECTION 232
LIME STABILIZED ROADBED

232.01 Description.

This Section shall cover the work of preparing a roadbed for an overlying base and paving structure by stabilizing it with a lime treatment.

The work shall consist of scarifying the roadbed, incorporation of lime, and the necessary processing thereof in accordance with one of the following methods to the proper grade, section, and density.

Class 1 Lime Stabilization shall consist of spreading and incorporating the specified percentage of lime in two increments in the following sequence: spreading the first increment, initial mixing, mellowing, spreading the second increment, final mixing, compacting, and finishing in accordance with these specifications. Mellowing is defined as the process of softening to a loamy consistency.

Class 2 Lime Stabilization shall consist of spreading the specified percentage of lime, initial mixing, mellowing, final mixing, compacting, and finishing in accordance with these specifications.

Class 3 Lime Stabilization shall consist of spreading the specified percentage of lime, mixing, compacting, and finishing in accordance with these specifications.

232.02 Materials.

All material furnished for use shall comply with the requirements of the appropriate Sections of Division 800, Materials. Water shall meet the requirements of Article 807.03; lime shall meet the requirements of Section 817.

The soil used in the stabilization shall consist of existing roadbed material or material added as directed. Particles of aggregate larger than those passing the 3 inch {75 mm} sieve, and deleterious substances such as roots, stumps, grass turfs, and other vegetable matter shall be removed from the soil.

232.03 Construction Requirements.

(a) General.

The basic requirement for work under this Section is to obtain a completed layer or layers of roadbed material containing a uniform lime mixture, with a smooth, closely knit surface, free from cracks, loose or segregated areas, and constructed to the proper depth, width, and surface requirement as specified.

Quantities and percentages of lime shown on the plans and proposal are based on preliminary soil investigation and dry laboratory sample tests. The actual application rate will be established from dry density tests made just prior to beginning stabilization work. The initial tests are based on Hydrated lime. If Quicklime is used and placed directly on the roadbed in pebble form, the percentage will be adjusted by the Engineer based on a factor of 0.833 times the hydrated lime percentage required. While either hydrated lime or quicklime may be used on different segments of the project, a second application of lime must be of the same type used in the first application.

It is necessary to the quality of lime treated materials that all such materials be kept moist at all times. It shall be the Contractor's responsibility to provide sufficient equipment and keep all partially constructed or completed lime stabilized layers sufficiently and continuously moist until a succeeding layer has been placed thereon or until final acceptance of the project.

(b) Equipment.

Choice of equipment to perform the work required under this Section shall, in general, be that of the Contractor provided such produces the desired results.

(c) Preparation of the Roadbed.

The roadbed shall have been prepared in accordance with the provisions of Section 210. The roadbed shall be scarified to the depth required for the stabilization prior to the lime application. The depth of scarification shall be carefully controlled so that the surface of the roadbed below the scarified material shall remain undisturbed and conform to the established cross-section. The scarified material shall be partially pulverized and all existing unsuitable material and material retained on a 3 inch {75 mm} sieve shall be removed.

(d) Application of Lime.

The rate of application of lime shall be as specified by the Engineer. When the lime is to be placed in two applications as designated for Class 1 Lime Stabilization and the design percentage equals 5 %, 3 % shall be placed in the first application unless noted otherwise on the plans. When the lime is to be placed in two applications as designated for Class 1 Lime Stabilization and the design percentage equals 7 %, at least 3 % but not more than 3.5 % shall be placed in the first application unless noted otherwise on the plans.

No lime shall be applied between October 1 and April 1 without written authorization of the Construction Engineer.

Application of the lime shall be accomplished by either an approved "dry application" or "slurry application" method. The slurry application method shall be used unless shown otherwise on the plans.

"Dry Application" - Lime applied by this method shall be spread uniformly and shall be sprinkled with water sufficient to prevent loss of lime by wind. Spreading of the lime when wind and weather conditions are unfavorable will not be permitted nor will spreading of the lime by motor patrol be acceptable.

"Slurry Application" - Lime applied by this method shall be mixed with water in approved agitating equipment and applied to the roadbed as a thin water suspension of slurry. The distributing equipment shall be equipped to provide continuous agitation from the mixing site until applied on the roadbed. The proportion of lime shall be such that the "Dry Solids Content" shall be at least 30 percent by weight {mass}.

NOTE: When quicklime is used, it shall be turned under by an approved means prior to application of water so as to reduce the harmful exposure to the heat of hydration by the quicklime.

The distribution of lime at the rate specified shall be attained by successive passes over a measured section until the specified percentage of lime has been spread. After each successive pass, the material shall be incorporated into the soil with the mixing equipment. Additional water, if necessary, shall be added and mixed into the mass to hasten mellowing.

Payment will not be made for any lime that has been spread and exposed before mixing for a period of six hours or more. Such areas shall be treated again with the full required rate of application. Additional lime shall be added at the Contractor's expense to any section on which excessive loss has occurred due to washing or blowing prior to mixing.

The quantity of lime applied on any section shall be spread uniformly and shall not vary more than plus or minus five percent of the quantity ordered for that section. No payment will be made for lime application exceeding the five percent plus tolerance. When the quantity applied is deficient by more than the allowable minus tolerance, additional lime shall be applied prior to mixing.

(e) Mixing.

1. Initial Mixing.

The lime and water shall be incorporated uniformly into the soil. The mixing and watering operation shall be continued until a homogeneous mixture that will pass a 3 inch {75 mm} sieve is obtained. After satisfactory mixing is obtained, the layer shall be reshaped to approximate line, grade and section and sealed with a light roller, if mellowing is required.

For Class 1 and 2 stabilization, the mixture shall be left to mellow for a minimum period of three days but not to exceed 21 days. During this period the entire surface of the stabilized layer shall be kept moist by sprinkling and at no time allowed to become dry or dusty.

For Class 3 stabilization, the moisture content during the mixing operation shall not vary more than two percent, plus or minus, from the laboratory specified optimum moisture. After mixing this material shall be compacted and finished as specified in Subarticles (f) and (g) below.

2. Final Mixing.

After the required mellowing period (Class 1 and 2), the layer shall be scarified and in the case of a Class 1 treatment, the second application of lime added. The layer shall then be remixed as prescribed in the initial mixing operations adding water. Mixing shall be continued until 100 percent of material by dry weight {mass}, exclusive of gravel and stone, will pass a 2 inch {50 mm} sieve and 60 percent will pass a Number 4 {4.75 mm} sieve. The percent moisture shall not vary more than two percent, plus or minus, from the laboratory specified optimum moisture during this mixing operation. If mixing cannot be completed in the same day begun, the surface of the layer shall be sealed by rolling with a rubber-tired roller before suspending that day's operation and the processing continued the following day, weather conditions permitting.

(f) Compaction.

Compaction of the mixture shall begin immediately after the required mixing operation noted above has been completed.

Compaction operations shall be completed within 72 hours after it was begun and so conducted as to provide uniform compaction from bottom to top of the layer. The mixture shall be aerated or watered as necessary to obtain the specified moisture content within two percent, plus or minus, of the laboratory specified optimum moisture. If compaction cannot be completed in the same day started, the surface shall be sealed by rolling with a rubber-tired roller before suspending that day's operation and the compaction continued the following day.

Throughout the entire compaction operation, depressions, defective areas, or soft spots which develop shall be corrected immediately by scarifying the area, adding lime when required, or removing the material and reshaping and compacting in accordance with these specifications at the expense of the Contractor.

Density requirements will be as specified in Section 306. Standard weights {masses} will be established on the project using material from the completed mixture, as directed by the Materials and Tests Engineer. The standard weight {mass} sample will be obtained and the standard weight {mass} established the same working day as the compaction tests are run.

If compaction cannot be obtained within the 72 hour limit noted herein in this Subarticle, the section involved shall be reprocessed adding additional lime in the increment directed by the Engineer and the compaction operation restarted, all of which shall be at the sole expense of the Contractor.

(g) Finish and Testing.

The surface of the layer shall be smooth and conform to the lines, grades, and cross sections shown on the plans or established by the Engineer. Surface requirements shall be as specified in Subarticle 230.03(e).

The thickness of the lime stabilized layer will be determined from measurements taken at intervals not to exceed 200 feet {60 m}. The thickness of the entire layer(s) shall not vary more than 1 inch {25 mm} plus or minus from that shown on the plans. Any section deficient by more than 1 inch {25 mm} shall be reconstructed immediately in accordance with these specifications. Any section exceeding the 1 inch {25 mm} tolerance shall have additional lime added to correct the deficiency and shall be remixed to the specified depth and width in accordance with these specifications. In each case, such reconstruction and additional lime added shall be at the sole expense of the Contractor.

(h) Protection, Curing and Maintenance.

Upon completion of the compaction and finishing of each layer, no vehicles or equipment other than watering equipment shall be permitted on the finished layer for a period of seven days unless otherwise authorized. During this curing period, the surface of the layer shall be lightly watered at frequent intervals to prevent drying.

The Contractor may, on a layer to be covered by a conventional base or subbase layer, substitute at his expense an acceptable prime coat in lieu of watering during the curing period noted above.

Regardless of the method of curing used, the Contractor shall be responsible for the protection and maintenance of the treated layer until it is covered by another layer or the completion of the project. Any damage to the treated layer due to other phases of construction or any cracking or other defects that may occur due to any cause or reason before being covered by the next layer shall be repaired without additional compensation.

232.04 Method of Measurement.

The actual area of the roadbed stabilized as ordered, for each specified compacted depth, completed to the thickness and cross-section shown on the plans or directed, will be measured in square

yards {square meters}. All calculations of areas measured for payment shall be based on measurements made to the nearest 0.1 yard {0.1 meter} with areas calculated to the nearest square yard {square meter}. The length will be measured along the surface of the completed roadbed at its center point. The width will be the top surface width of the completed roadbed specified on the plans or directed, measured perpendicular to the center line of roadbed. Additional areas required for cross overs, turnouts, etc., shall be measured by length and width along the surface of area processed.

Lime actually incorporated in the work will be measured by the ton {metric ton}. In cases where Pure Quicklime (CaO) is slaked on the jobsite to produce a lime slurry, the pay quantity for lime will be measured in tons {metric tons} of hydrated lime as calculated using the certified lime purity for each truckload as follows:

TOTAL TONS {METRIC TONS} HYDRATED LIME PRODUCED = (A x B x 1.32) + A (1.0 - B)

Where: A = tons {metric tons} of Quicklime delivered
B = certified percent purity

Note: 1.32 = ratio of Molecular weights {masses} for Hydrated Lime (74) and Pure Quicklime (56)

232.05 Basis of Payment.

(a) Unit Price Coverage.

The ordered and accepted area of lime stabilization, measured as noted above, will be paid for at the contract unit price bid per square yard {square meter} of the class and depth specified. Said unit price bid shall be full compensation for all scarifying, pulverizing, mixing, shaping, watering, compacting, and application of lime and for all equipment, tools, labor, and incidentals necessary to complete and maintain the work.

The accepted quantity of lime actually incorporated in the work except as noted herein, measured as provided above, will be paid for at the contract unit price per ton {metric ton} for lime, which price shall be payment in full for furnishing, transporting, storing, handling, preparation of slurry, and spreading; and for all equipment, tools, labor, and incidentals needed for completion of the work.

Any additional soil material required to bring the roadbed to plan grade and section, and any unsuitable material excavated, will be measured and paid for under the appropriate item of Unclassified Excavation or Borrow. No direct payment will be made for blading, shaping, compacting, and like operations.

(b) Payment will be made under Item No.:

232-A Lime Stabilization, Class ____ , ___ inches {mm} Thick - per square yard {square meter}
232-B Lime - per ton {metric ton}

SECTION 235
DETOUR BRIDGES

235.01 Description.

The work under this Section shall cover the work of furnishing all materials, construction, maintenance, and removal (unless otherwise directed) of any temporary detour bridge structure at the approximate location shown on the plans or directed.

235.02 Materials.

All timber used shall be a minimum of dense No. 1 structure grade pine or equivalent grade of other wood.

Steel or other types of bridging material may be used; however, the grade of material used must be approved by the Bridge Engineer.

Other materials shall conform to the requirements noted elsewhere in these Specifications for the type material used.

235.03 Construction Requirements.

(a) General.

The alignment, length of bridge, grade, and typical cross-section will be shown on the plans.

All construction shall be consistent with the requirements for the type work involved as noted in other portions of these Specifications.

(b) Bridge Requirements.

If the detour bridge design is not shown on the plans, then, before construction of a detour bridge may be begun, the Contractor shall submit to the Construction Engineer a minimum of six prints of detailed drawings for the structure he proposes to furnish in accordance with 105.02. Prior to submittal, all drawings shall be checked, stamped approved, and signed by a licensed Professional Engineer licensed in the State of Alabama and not employed by the Alabama Department of Transportation. The structure shall be designed to carry HS20 loading giving consideration to all vertical and lateral loads to be applied to the structure in accordance with the current edition of the AASHTO Standard Specifications for Highway Bridges using the Service Load Design Method. The Contractor, at his discretion, may exceed these requirements to reduce his maintenance or replacement expense.

No work shall be performed on the structure until after distribution of the plans has been made to the Area, District, and Project Managers. The Contractor will be required to comply with the details of the plans as approved.

The Contractor shall take full responsibility for the proper structural design, construction, and maintenance of the facility.

The licensed Professional Engineer who signed the detour bridge submittal shall verify that the detour bridge as constructed meets all design criteria prior to any load being placed thereon. A signed statement from the licensed Professional Engineer covering the verification shall be furnished to the Project Manager by the Contractor.

235.04 Method of Measurement.

No direct measurement or payment will be made for a detour bridge unless it is listed in the pay items of the contract. The detour bridges listed in the proposal will be identified by the station number of its location and measured as a Lump Sum Unit.

235.05 Basis of Payment.

(a) Unit Price Coverage.

Detour bridges for which an item is provided in the proposal will be paid for at the contract lump sum price bid. Said lump sum shall be payment in full for furnishing all materials, equipment, and labor necessary for the construction, maintenance, and removal (if required) of the detour bridge.

No direct payment will be made for detours which the Contractor builds for his own convenience.

(b) Payment will be made under Item No.:

235-A Detour Bridge at Station _____ - per lump sum

SECTION 243
GEOSYNTHETICS FOR SLOPE AND SOFT SOIL REINFORCEMENT

243.01 Description.

This section covers the installation of geosynthetic soil reinforcement for the reinforcement of soil slopes and for soft soil stabilization.

A "geosynthetic soil reinforcement" material shall be any planar geosynthetic (geogrid or geotextile) material designed for the purpose of improving the shear strength of the soil matrix.

243.02 Materials.

The geosynthetic reinforcement (either geogrid or geotextile) shall be constructed of polyester, polypropylene, or polyethylene polymer, resistant to all naturally occurring alkaline and acidic soil conditions, resistant to heat, ultraviolet light, and to attack by bacteria and fungi in the soil.

Applicable test methods for measuring strength and creep are:

- ASTM D 4595 "Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method"
- ASTM D 5262 "Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics"
- ASTM D 6637 "Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method"

Reinforcement for soil slopes shall be any geosynthetic whose strength in the machine direction equals or exceeds the values shown in the following table:

SOIL SLOPE REINFORCEMENT TYPE	CREEP REDUCED STRENGTH AT A 10 % TOTAL STRAIN LIMIT (minimum) pounds per foot {kN/m}	TEST METHOD *
1	1000 {14.6}	ASTM D 5262
2	2500 {36.5}	
3	3400 {49.6}	
* Ultimate Strength measured in accordance with ASTM D 4595 or D 6637.		

Reinforcement for soft soil stabilization shall be any geosynthetic whose strength equals or exceeds values shown in the following table:

SOFT SOIL STABILIZATION REINFORCEMENT TYPE	ULTIMATE STRENGTH, MACHINE DIRECTION (minimum) pounds per foot {kN/m}	ULTIMATE STRENGTH, CROSS MACHINE DIRECTION (minimum) pounds per foot {kN/m}	STRENGTH AT 5% STRAIN, MACHINE DIRECTION (minimum) pounds per foot {kN/m}	STRENGTH AT 5% STRAIN, CROSS MACHINE DIRECTION (minimum) pounds per foot {kN/m}	TEST METHOD
1	900 {13.1}	900 {13.1}	500 {7.3}	500 {7.3}	ASTM D 6637 ASTM D 4595
2	1300 {19.0}	1300 {19.0}	800 {11.7}	800 {11.7}	
3	2100 {30.7}	2100 {30.7}	1200 {17.5}	1200 {17.5}	

243.03 Receipt, Inspection and Certification.

Reinforcement geosynthetics delivered to ALDOT projects shall be packaged, identified, stored, and handled in accordance with the requirements given in ASTM D 4873 "Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples".

Each roll of delivered material shall be individually marked to permit direct correlation with the applicable production Lot Number.

Delivered material shall be accompanied by a manufacturer certified copy of test results (ASTM D 4595 for Geotextiles or ASTM D 6637 for Geogrids) verifying the ultimate strength of the Lot(s) from which delivered rolls of reinforcement were obtained.

Deliveries of reinforcement that are improperly packaged, marked and/or lack manufacturer certified Lot test results (ASTM D 4595 for Geotextiles or ASTM D 6637 for Geogrids) will not be accepted by the Project Manager. One sample per reinforced slope shall be taken in accordance with Acceptance Sampling and Testing Schedule Section 605.

243.04 Construction Requirements.

All areas immediately beneath the installation area for the geosynthetic reinforcement shall be properly prepared as detailed on the plans, specified elsewhere within the specifications, or directed by the Engineer.

In general, the reinforcement shall be installed in accordance with the manufacturer's recommendations and shall be placed within the layers of the compacted soil as shown on the plans or directed.

Only that amount of geosynthetic reinforcement required for immediately pending work shall be placed to prevent undue damage to the reinforcement.

After a layer of geosynthetic reinforcement has been placed, suitable means such as pins, small piles of soil, or other fixation means as recommended by the manufacturer shall be used to hold the geosynthetic reinforcement in position until the subsequent soil layer can be placed. Under no circumstance shall a track-type vehicle be allowed on the reinforcement before at least 8 inches {200 mm} of soil have been placed on the reinforcement. Soil layers shall be constructed in accordance with Section 210.

The overlapping of the geosynthetic reinforcement shall be as required by the plans. If a specific overlap is not required by the plans, individual pieces of reinforcement shall typically be installed side by side with the "machine direction" of the material oriented in the direction of required reinforcement.

When the delivered width is greater than the width of geosynthetic reinforcement required, the reinforcement may be cut with a razor, knife, abrasion saw, or similar tool. As an alternate to cutting,

the Contractor may be allowed to turn the excess portion of the reinforcement under, provided an acceptable installation is obtained. That portion of reinforcement cut off or turned under will not be measured for payment.

If a geotextile is required in conjunction with one or more layers of geosynthetic reinforcement, it shall be installed as shown on the plans or directed by the Engineer.

243.05 Method of Measurement.

The quantity of geosynthetic soil reinforcement, measured for payment, will be the number of square yards {square meters} of material installed and acceptably placed. No measurement will be made for portions cut off, overlaps, or portions not needed but allowed to remain in the fill.

243.06 Basis of Payment.

(a) Unit Price Coverage.

The quantity of geosynthetic soil reinforcement placed and measured as noted above will be paid for at the contract unit price bid per square yard {square meter}, which shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

243-A Geosynthetic Reinforcement for __*__, Type __**__ - per square yard {square meter}

* Either "Reinforced Slopes" or "Soft Soil Stabilization";

** Enter type of reinforcement, Type 1, 2, 3, etc.

SECTION 250
REMOVAL OF UNDERGROUND STORAGE TANKS AND CONTAMINATED SOIL

250.01 Description.

This Section shall cover the removal and disposal of underground storage tanks for petroleum based hydrocarbons and the removal and disposal of contaminated soil. The term underground storage tank (UST) includes the UST and all components (pump lines, vent lines, distribution lines, etc.) of the tank. This Section shall also cover the removal and disposal of the contents of the UST and the backfilling of the areas of removal.

The approximate extent of the known contamination will be shown on the plans. The actual limits of contamination will be determined in the field with verification sampling at the time of UST removal.

The treatment of groundwater after the removal of the USTs will be done under a separate contract.

250.02 Materials.

Material requirements are not given for the work required under this Section. The furnishing and placement of materials is covered under other Sections.

250.03 Construction Requirements.

(a) Regulatory Requirements and Permits.

All work shall be in conformance with the rules and regulations of the Alabama Department of Environmental Management (ADEM), the Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA).

For the purposes of conducting work for the ALDOT, the term "Generator" shall be defined as any person who utilizes any process that results in the production of a solid waste. The Contractor, not the Engineer, will be responsible for signing all regulatory documentation as the "Generator".

If contaminated material is transported to or through another state, work performed in that state shall be in conformance with any applicable regulatory requirements in the state involved.

The Contractor shall obtain all permits that may be required for the handling, hauling and disposal of the petroleum hydrocarbon liquids and sludge and contaminated soil.

(b) Contractor's Notification of Schedule to Remove USTs.

The Contractor shall notify ADEM at least 30 calendar days before beginning the excavation work to remove a UST. The Contractor shall also provide the Engineer with a copy of the notification and any

acknowledgements of the notification returned by ADEM. At least 7 calendar days in advance of excavation and removal, the contractor shall notify the Engineer to insure that appropriate personnel are on site to obtain samples and data as necessary for the verification testing. The ALDOT will do all site assessment and verification testing.

(c) Removal and Disposal of UST and Excavation Pit Contents.

The Contractor shall remove liquids and sludges from a UST by pumping these materials out of the UST before it is removed from the ground. USTs may contain different types of petroleum hydrocarbons (gasoline, diesel, sludge, oil, etc.). Small amounts of liquids and sludges that cannot be pumped from a UST and cannot be removed from the appurtenances to the UST (distribution lines, pump lines, etc.) shall be collected after the removal of the UST. Leakage from the UST onto the surrounding soil shall be avoided by properly pumping the contents of the UST into permitted transport vehicles. Any liquids or sludges associated with the UST system that are present or released into the excavated pit shall be removed and disposed.

The liquids and sludges shall be removed in accordance with the requirements given in the National Fire Protection Association Flammable and Combustible Liquids Code (NFPA-30) and ADEM requirements.

The Contractor shall dispose the liquids, sludges and other materials removed from the USTs and the materials collected from the appurtenances to the USTs. The Contractor shall furnish the Engineer with a copy of the documentation of the disposal (disposal receipts, manifests, weight tickets, etc.).

(d) Excavation of Potentially Contaminated Soil.

The Contractor shall excavate the potentially contaminated soil to the extent designated by the Engineer. The Contractor shall furnish, install and maintain all hazard warning markings and devices at the areas of excavation that may be required by regulation.

The soil shall be placed in separate loads for testing. A typical load for testing shall not be greater than 20 cubic yards {15 cubic meters}, but may be a larger or smaller load that the Engineer designates as being acceptable for testing.

Loads shall be kept separate to maintain the integrity of the testing and disposal. Loads shall be isolated by plastic sheeting (minimum thickness 6 mils) or by being placed in holding bins or other containers to prevent further contamination. The stockpiled material shall be placed so that soils are not released into the surrounding environment by erosion.

After the results from the verification testing have been obtained, the Engineer will inform the Contractor of what should be done with the soil. If the Engineer determines that the level of contamination does not warrant the disposal of the soil as contaminated soil, it shall be incorporated into the earthwork or shall be disposed by the Contractor in accordance with the requirements given in Section 210.

Contaminated soil shall be kept separate from soil that is not contaminated.

(e) Removal and Disposal of USTs.

USTs shall be removed after the liquids and sludges have been removed from the USTs and the appurtenances to the USTs. USTs and connections shall be completely empty prior to disposal. All lines (product lines, vent lines, etc.), connections and other appurtenances shall be removed. The method of UST disposal shall be submitted to the Engineer for approval. The Contractor shall furnish the Engineer with a copy of the documentation of the disposal of the UST and appurtenances (disposal receipts, manifests, weight tickets, etc.).

(f) Disposal of Contaminated Soil.

The Contractor shall deliver the contaminated soil to a disposal site (landfill, incinerator, etc.) that meets all regulatory requirements for the disposal of the contaminated soil. Documentation (receipts, manifests, mass tickets, etc.) of the delivery shall be provided to the Engineer.

Contaminated soil shall not be treated on site prior to disposal and shall not be removed to an alternate site for remediation prior to disposal.

(g) Backfill.

Backfilling the excavated areas will not be permitted until authorized by the Engineer. Backfill within the limits of the roadway shall be in conformance with the requirements given in Section 210. All other backfill shall be placed, tamped and compacted to the consistency of the surrounding material. Backfill shall be compactable soil of an acceptable quality.

250.04 Method of Measurement.

(a) Disposal of Hydrocarbon Contaminated Soil.

The disposal of hydrocarbon contaminated soil will be measured by the cubic yard {cubic meter}.

Soil that is not disposed as contaminated soil and is incorporated into the earthwork or disposed by the Contractor will be measured by the cubic yard {cubic meter}.

(b) Underground Storage Tank Removal.

The removal of a tank will be measured per each tank removed.

(c) Removal and Disposal Of Tank Contents.

The quantity of tank contents removed and disposed will be measured in gallons {liters} as metered or computed from field measurements. This Pay Item does not include liquids generated during the tank cleaning process.

250.05 Basis of Payment.

(a) Unit Price Coverage.

1. Disposal of Hydrocarbon Contaminated Soil.

The contract unit price for the disposal of hydrocarbon contaminated soil shall be full compensation for the excavation and handling of the soil, securing the site, hauling, disposal, and for all equipment, tools, labor and incidentals necessary to complete the work. The contract unit price shall also be full compensation for all expenses required for compliance with rules, statutes, laws and regulations that cover the removal and disposal of the contaminated soil.

The contract unit price for the disposal of the hydrocarbon contaminated soil shall also be full compensation for incorporating uncontaminated soil into the earthwork or disposal of uncontaminated soil. The quantity of uncontaminated soil will be reduced by 75 % to allow payment to be made at the same price as the disposal of hydrocarbon contaminated soil.

Backfilling of excavated areas will be covered under other items of work.

2. Underground Storage Tank Removal.

The contract unit price for the removal of an underground storage tank shall be payment in full for all materials, equipment, tools, labor and incidentals necessary for the removal and disposal of the tank and appurtenances. The contract price shall include cleaning the tank, and all appurtenances.

3. Removal and Disposal of Tank Contents.

The contract unit price for the removal and disposal of tank contents shall be full compensation for all equipment, tools, labor and incidentals necessary for removing and disposing the tank contents.

(b) Payment will be made under Item No.:

250-B Disposal of Hydrocarbon Contaminated Soil (SPECIALTY ITEM) - per cubic yard {cubic meter}
250-C Underground Storage Tank Removal (SPECIALTY ITEM) - per each
250-N Removing and Disposing Tank Contents (__*__) (SPECIALTY ITEM) - per gallon {liter}
* Specify "Gasoline", "Diesel", "Sludge", "Oil", etc., if required.

SECTION 260
CEMENT MORTAR FLOWABLE BACKFILL

260.01 Description.

This Section shall cover the work of placing a low strength flowable cement mortar as a backfill at driven piles, drainage structures, utility cuts, and at other locations shown on the plans or directed by the Engineer.

260.02 Materials.

All materials furnished for use shall comply with the appropriate requirements of Division 800, Materials, and the requirements noted hereinafter in this Section. Specific reference is made to the applicable portions of the following Sections:

- Section 802 - Fine Aggregates

- Section 806 - Mineral Admixtures
- Section 807 - Water
- Section 808 - Air Entraining Additives
- Section 815 - Cement

Unless approved otherwise by the Engineer, the following materials shall be used: fine aggregate shall be concrete sand, fly ash shall be either Class "C" or Class "F" ash, and cement shall be Type I for Mixes 1, 2, 3, and 4 and Type II for Mix 5.

Cement mortar shall be proportioned in accordance with the requirements given in Table 2 (Master Proportion Table). Variations to the amounts of the components in a mix may be requested in writing from the Materials and Tests Engineer to achieve a more desirable consistency, workability, or stability in the mix. Requests to reduce the amount of cement, fly ash, or air entrainment will not be approved.

TABLE 2 - MASTER PROPORTION TABLE - ONE CUBIC YARD {CUBIC METER} PROPORTIONS.

Mix Designation	1	2	3	4	5
Cement (lbs.) {kg} (minimum)	61 {28}	185 {84}	195 {88}	195 {88}	90 {40}
Fly Ash (lbs.) {kg} (minimum)	331 {150}	-	572 {259}	572 {259}	1800** {820}
Fine Aggregate (lbs.) {kg}	2859 {1300}	2673 {1210}	2673 {1210}	2673 {1210}	-
Water (lbs.) {kg}	509 {230}	500 {227}	488 {221}	488 {221}	750 {340}
Air (oz.) {g} (minimum)	-	5.2 {147}	-	-	-
Accelerator (oz.) {g} *	-	-	-	45.2 {1280}	-

* The accelerator dosage will vary from brand to brand. Adjust for desired results.
** Class “F” fly ash with a maximum LOI of 15% and a maximum moisture of 25%

Cement mortar shall have the physical properties given in Table 3 (Cement Mortar Physical Property Table).

TABLE 3 - CEMENT MORTAR PHYSICAL PROPERTY TABLE

Mix Designation	1	2	3	4	5
Compressive Strength					
3-day (psi) {kPa} (minimum)	20 {138}	70 {483}	300 {2070}	360 {2480}	15 {105}
7-day (psi) {kPa} (minimum)	30 {207}	130 {896}	500 {3450}	550 {3790}	30 {210}
28-day (psi) {kPa} (minimum)	70 {483}	150 {1030}	900 {6210}	1000 {6890}	50 - 150 {350 – 1030}
Penetration Resistance					
12-hr. (psi) {kPa} (minimum)	-	450 {3100}	500 {3450}	1600 {11,000}	-
24-hr. (psi) {kPa} (minimum)	250 {1720}	2500 {17,240}	8500 {58,600}	-	100 {700}
48-hr. (psi) {kPa} (minimum)	700 {4830}	-	-	-	240 {1660}

260.03 Construction Requirements.

(a) Equipment.

The Contractor shall furnish equipment capable of producing mortar meeting the requirements noted in this Section. All equipment must be in good working order and so maintained throughout the

requirement for its use. Unless authorized otherwise, in writing, by the Engineer, the mixing and transporting equipment shall meet the requirements of Item 501.03(b)2.

(b) Preparation of Mortar.

During the mixing operation, the sand, fly ash, and cement shall be introduced in that order. The water and any admixtures, shall be added and the mortar allowed to mix for three minutes.

(c) Weather Limitation.

No mortar shall be placed when the ambient air temperature is below 40 °F {5 °C}, without written permission of the Engineer.

(d) Placement of Mortar.

The mortar may be placed by direct discharge from the transporting vehicle, by pumping, or by any other method approved by the Engineer. The mortar material shall be brought up uniformly to the elevation or fill line shown on the plans or directed by the Engineer. To prevent damage to the low strength mortar, the freshly placed mortar shall not be subjected to load and shall remain undisturbed by construction activities for the following time periods unless approved or directed otherwise by the Engineer: Mix 1 - 48 hours; Mix 2 - 16 hours; Mix 3 - 16 hours; Mix 4 - 12 hours; Mix 5 - 48 hours.

260.04 Method of Measurement.

Cement Mortar Flowable Backfill will be measured for payment in cubic yards {cubic meters} of mortar, of the designated mix, as ordered and approved by the Engineer and acceptably placed.

260.05 Basis of Payment.

(a) Unit Price Coverage.

Cement mortar flowable backfill will be paid for at the contract unit price for the designated mix. This price shall be full compensation for furnishing of the mortar, including all ingredients, for the mixing, placing, and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

260-A Cement Mortar Flowable Backfill, Mix ___ - per cubic yard {cubic meter}

DIVISION 300
BASES

SECTION 301
SOIL, SOIL AGGREGATE, AND AGGREGATE, BASE AND SUBBASES

301.01 Description.

(a) General.

This section shall cover the work of furnishing all materials and the construction of Soil, Soil Aggregate, and Aggregate, base and subbase courses, complete in place on the roadbed.

Typical cross section, thickness, number, and material classification of the course will be shown in the plans or proposal.

(b) Classification.

The base or subbase materials are established by general classifications such as "Selected Materials", "Granular Soils", "Soil Aggregate", "Processed Reef Shell", and "Aggregates", and consist of natural soil, natural soil and natural aggregate combinations, or manufactured (commercial) aggregates, either used separately or blended in any combination with or without a stabilizing agent. Additional classification of the material by "Type" according to the required gradation and composition of the material in the completed base or subbase course have been tabulated in Sections 820, Selected Materials For Bases; 821, Granular Soil Materials; 822, Drainage Plane Materials; 823, Soil Aggregate Materials; 824, Processed Reef Shell Base Materials; and 825, Crushed Aggregate Base Materials.

The bases and subbases will be further established by the method of mixing, (Road, Yard, or Plant) as described in Article 301.03. The general classification, type, and method of mixing will be shown in the proposal. Special details will be shown on the plans.

301.02 Materials.

All materials furnished for use shall comply with the requirements of the applicable sections of Division 800, Materials, except as modified by the plans or proposal.

Attention is directed to:

- Section 807 Water
- Section 815 Cement
- Section 817 Lime for Roadbed & Base Stabilization
- Section 820 Selected Materials for Bases
- Section 821 Granular Soil Materials
- Section 822 Drainage Plane Materials
- Section 823 Soil Aggregate Materials
- Section 824 Processed Reef Shell Base Materials
- Section 825 Crushed Aggregate Base Materials

Preliminary tests of optional sources shown on the plans indicate that the materials from these sources will meet plan requirements, either in their natural composition or by blending with additional material. However, whether sources are shown on the plans or not, the Contractor shall supply whatever components are needed, in whatever proportions are necessary, to meet specified requirements of the plans and specifications for the item complete in place.

The processed materials, in addition to complying with the requirements noted above, must be capable of being compacted to the density requirements noted in this Section. Any material furnished, regardless of compliance with all other requirements, which cannot be compacted to the densities specified shall be either removed and replaced with more suitable material, or corrected.

Testing of material will be as provided in Article 301.05.

301.03 Construction Requirements.

(a) General.

The roadbed must be in an approved condition before placement of any base or subbase will be permitted. Approval shall be based on satisfactory completion of the roadbed in accordance with the requirements of Sections 210 and 230 and, if required by the plans or proposal, the additional modification of the roadbed in accordance with the provisions of either Section 231 or 232.

The roadbed shall be checked carefully for elevations established by the Engineer and shall be true to alignment and grade within the limits specified in Subarticle 230.03(e). Control elevation stakes will be set as provided in Article 105.08.

On a contract for base and pavement only, the roadbed, in addition to the check for continuity of grades, shall be checked for density as required by the process used in construction of the subgrade (Section 230, 231 or 232). Loss of density shall require reprocessing of the top layer (6 inches {150 mm}) of the subgrade in accordance with Section 230 by the method prescribed by the plans for the roadbed treatment. Low areas shall be corrected by the addition of material and reprocessing under the method prescribed for the roadbed treatment; minor high spots shall be eliminated during the dressing of the processed roadbed. Material ordered used for the correction of low areas in the subgrade shall be measured and paid for under the appropriate classification of the material ordered used. If no item for an acceptable type material is provided in the contract, such shall be furnished under the provisions of Article 104.03.

A base of up to 6 inch {150 mm} plan designated compacted thickness may be constructed in one layer. Unless otherwise shown on the plans, a base of over 6 inch {150 mm} thickness shall be constructed in approximately equal layers each of not over 6 inch {150 mm} compacted thickness.

Protection of base layers during construction shall be the Contractor's responsibility.

(b) Equipment.

In general, it shall be the Contractor's responsibility to select and furnish the proper size and amount of equipment that will produce and deliver to the roadbed, mix, spread, shape, and compact the base material.

When cement or lime additives are required, all equipment necessary for the proper prosecution of the work shall be assembled on the site, approved and in good working order before permission to start processing the layer will be given.

All equipment approved for use will be on a trial basis, and if after a short test section the equipment should prove unsatisfactory, it shall be removed, replaced, or supplemented as deemed necessary to accomplish the desired work.

(c) Mixing.

1. General.

There are three methods of mixing base and subbase materials; they are road mixing, yard mixing, and plant mixing. Yard and plant mixing are considered as premixing. The Contractor may substitute yard or plant mixing in lieu of road mixing, or plant mixing in lieu of yard mixing, if so requested in writing.

All mixing shall be performed in such a manner that all materials or component parts are thoroughly blended and mixed to a uniform gradation and color, with equipment and operation thereof producing consistently satisfactory results. Mixing water shall be added in a manner that will provide uniform blending with the material being mixed.

Soft or unsatisfactory spots shall be removed and/or repaired as directed by the Engineer at no expense to the Department.

2. Road Mixing.

a. General.

Roadmixing shall be performed by a motor grader supplemented, if necessary, by other approved mixing equipment that will produce consistently satisfactory results.

Base materials may be dumped directly on the subgrade, subbase, or underlying layer. The Contractor is encouraged, but not required, to use adjustable aggregate spreaders to place and spread commercial or crushed aggregates.

The dumping operation shall be limited to the amount of materials which can be mixed by the end of the next day. This material shall be shaped and compacted no later than the day after mixing. In no instance shall the shaping and compacting be later than the second day after the dumping operation. No deviation from the above will be allowed without written permission of the Engineer.

The bottom layer shall be mixed without disturbing more than 1 inch {25 mm} of the roadbed or underlying layer. Mixing of subsequent layers shall include scratching lightly of the surface of the underlying layer for bonding effect.

Mixing shall be sufficiently performed to distribute all component parts of the layer uniformly throughout the mass producing a material of uniform color and gradation throughout the depth, width, and length, insofar as practical as determined by the Engineer, of the layer. Mixing shall include, but not be limited to, the windrowing and blading of the material as necessary to obtain the required consistency. Water shall be applied as necessary during the mixing operation to provide, at the time of compacting, a uniform moisture content within two percentage points of optimum as established by the required laboratory test. The material shall be aerated as often as necessary to correct excess moisture conditions by scarifying, plowing, harrowing, blading, or by using special, suitable equipment.

b. Stabilization Using Additives.

(1) General.

It is necessary to the quality of the stabilization operation that careful control of the volumes of the base material, the additive, and moisture be exercised and that equipment furnished be capable of producing the desired results within the time frame noted herein of the type treatment involved; otherwise, the resultant product will be unsatisfactory. It shall be the Contractor's responsibility to provide suitable equipment, adequately sized and in sufficient numbers to process the materials as required.

Each layer of base or subbase with an additive shall be processed through a test section utilizing equipment and methods noted for the type treatment involved. This test section shall be used to establish acceptability of the Contractor's equipment and processing technique along with determining the correct volume of material(s) necessary to obtain the required depth shown on the plans or ordered in writing. The length of the test section shall be determined by the Engineer to best fit the required type of processing specified by the plans or proposal, but shall not exceed one-half mile {800 m} nor be less than 500 feet {150 m}. The material shall be placed and spread, mixed if not premixed, and processed through the entire operation normally required for the type of layer involved. The layer shall then be checked for proper additive content, density, and depth, and any deficiencies corrected as provided in Article 301.05. Satisfactory completion and acceptance of the test section will be required before the remaining work on the layer being tested is permitted. The data thus obtained from the test section shall be applied to the placement procedure of the remainder of the layer involved.

(2) Placing and Mixing.

All materials, except the additive, shall be placed as noted in Subitem a. above.

Placement of the additive will be allowed only after the initial mixing and blending described in Subitem a. above has been accomplished.

Upon completion of the above operation, the additive shall be spread uniformly over the area to be treated using approved methods and equipment. The additive shall then be incorporated with the material to be treated in such a manner as to provide uniform distribution of the additive throughout the designated width and depth of treatment.

Control of moisture shall be so exercised that the optimum moisture content (± 2%) is present during the initial mixing of the materials to be treated and the additive.

The use of lime and cement additives require special handling in accordance with the following:

Lime Treatment.

Lime treatment shall not be performed between October 1 and April 1 without written permission of the Engineer. Lime shall be spread only on that area which can be processed in the same working day. Any lime that has been spread and exposed to the air before mixing for a period of six hours or more, or any section of the work on which excessive loss of lime has occurred due to washing or blowing will not be accepted for payment. Such areas shall be treated again with the full required rate of application before acceptance.

After preparation of the material to be treated has been accomplished, the application of the lime shall be accomplished by either the "dry application" or the "slurry application" method described in Subarticle 232.03(d) except that the "dry application"

method shall not be used where the resultant dust from the dry method would affect the visibility of the traveling public or affect adjacent property owners.

The actual rate of application of the lime will be set by the Engineer based on the standard density of the material to be treated as determined by AASHTO T 180.

The quantity of lime applied on any section shall be spread uniformly and shall not vary more than plus or minus five percent of the quantity ordered for that section. No payment will be made for lime application exceeding the five percent plus tolerance. When the quantity applied is deficient by more than the allowable minus tolerance, additional lime shall be applied and the deficient section reconstructed in accordance with these specifications for the full depth and width at no extra compensation.

The mixing of the lime with the base materials shall be accomplished utilizing traveling mixers capable of handling the required depth of material (loose), the lime, and the water necessary to provide the designated optimum moisture content. The blended material shall then be processed in the same manner noted in Item 301.03(d)3 for lime treated bases.

Deficiencies in the thickness of the lime stabilized layer in excess of those specified in Subarticle 301.05(d) shall be reconstructed immediately adding additional lime if deemed necessary by the Engineer. Any additional lime and such reconstruction shall be at the sole expense of the Contractor.

Cement Treatment.

Cement treatment shall not be performed when the ambient ground temperature in the shade is below 40 °F {4 °C}. Should the air temperature drop below 35 °F {2 °C} after incorporation of the cement, protection shall be provided to prevent damage of the processed layer. Cement shall only be spread on the area that can be processed in the same working day. Any cement that has been spread and exposed to the air before mixing in excess of six hours or more, or any section on which excessive loss of cement has occurred due to wind or rain, will not be accepted for payment. Such areas shall be reconstructed with the required rate of treatment before acceptance at the sole expense of the Contractor.

After the placement and processing of the base material to be treated, the cement shall be spread utilizing equipment specially designed for the purpose. The actual rate of application of the cement will be set by the Engineer based on the standard density of the material to be treated as determined by AASHTO T 180. The quantity of cement shall be spread uniformly over the area to be treated and shall not vary more than five percent from the specified rate. Care shall be exerted to prevent loss of cement due to wind or other unfavorable conditions.

The mixing of the cement with the base material shall be restricted to traveling mixers capable of handling the required depth of material (loose), the cement, and the water necessary to provide the designated optimum moisture content. When the mixer will handle only a part of the roadbed width, the successive increments shall be of such length that the full width of material may be promptly mixed, compacted, and finished with not more than 30 minutes between mixing adjacent widths (lanes). The base and cement mix shall then be processed in the same manner noted in Item 301.03(d)2 for the cement treated bases.

Should the thickness of treatment be found to be outside the tolerance noted in Subarticle 301.05(d) within two hours after completion of compaction and shaping, the Engineer may allow the reprocessing of the section provided additional cement is added in an amount to be designated by the Engineer without additional cost to the Department or handled as noted in Item 301.05(d)3.

3. Yard Mixing.

Unless otherwise provided on the plans, the mixing yard shall be furnished by the Contractor.

Yard mixing shall be accomplished by spreading each component in a layer of uniform width and thickness before placing the next component; then thoroughly mixing the materials by means of a motor grader supplemented, if necessary, by other approved mixing equipment that will produce consistently satisfactory results. The mixing shall be sufficient to combine all components into a mixture of uniform color and gradation adding water as necessary to obtain a uniform moisture content within two percentage points of optimum as established by the required laboratory test. The

mixture shall then be loaded into transporting vehicles by means that will prevent segregation of materials.

If calcium chloride or another similar additive is specified as a component of the mix, the additive shall be spread in the amount specified in the proper mixing sequence and mixing continued until the additive has been thoroughly mixed uniformly into the mixture.

4. Plant Mixing.

a. General.

All of the following construction procedures are required for the base and subbase materials to be classified as Plant Mixed materials: mixing material in a plant or pugmill; dumping material directly into a truck; hauling material to the project site; and dumping material directly into a spreader that will spread the material into uniform layers of the required cross sections and thicknesses.

Material that is dumped, stockpiled, and/or rehandled prior to spreading will be classified as Road Mixed or Yard Mixed material.

b. Mixing Plant Requirements.

The mixing plant requirements are as follows; however, any other mixing plant equipment developed that will produce equally satisfactory results will be acceptable for use with the approval of the Engineer.

(1) The plant shall be an approved contra-rotating twin-shaft pug-mill type central mixing plant of proven performance and adequate capacity. The plant shall be equipped to proportion accurately by volume or weight {mass}.

If proportioned by volume, component materials shall be fed onto a primary belt by a separate secondary belt for each component. Accurate proportioning shall be secured by positive control of secondary belt speed or by adjustable locking gates feeding onto the belt, The mixed materials shall be discharged through a surge hopper of at least 1 cubic yard {1 m^3} capacity. The mixer also shall have an approved, accurate, mechanically-fed device for adding cement or other additive at a specified rate when such components are required.

If proportioned by weight {mass}, equipment used to determine the weight {mass} of aggregates shall meet the requirements of Article 109.01. Weight {Mass} type mixers shall be equipped with a locking batch timer, adjusted for a minimum 30 second net mixing time.

(2) The controls that operate the mixing plant shall be positioned so that the operator will have unobstructed vision of all phases of the operations that affect the proportioning of materials. The plant shall be equipped with an approved device for signaling the control operator to stop the plant when any malfunction occurs in the feed-in system.

(3) The mixer shall be equipped with an accurate adjustable water meter device for controlling moisture content.

(4) Storage bins shall be equipped with overflow pipes or chutes, and shall be so partitioned that there can be no spill-over into adjacent bins. Storage bins for calcium chloride, lime, or cement shall be water tight.

c. Mixing Plant Operation.

(1) During the mixing operation the aggregate shall be introduced into the mixer in a way that will insure the proportion of each type of material to be used will be in the final mixture.

(2) Water shall be added to the mix in an amount that will produce a uniform moisture content, based on dry weight {mass} of the mixture, within two percentage points of optimum as established by the required laboratory test.

(3) When required, cement shall be added to the other components of the mix in the proportions as directed, except that the Engineer may vary the amount of cement by as much as 20 percent, plus or minus. After the required amount of cement has been set by the Engineer, the rate shall not vary more than 5 pounds {2 kg}.

When required, lime shall be added to the other components of the mix in the proportions as directed. The quantity and percentage of lime shown on the plans or proposal are based on preliminary investigations and dry laboratory samples. The actual rate or amount to be added will be determined from density tests made just prior to beginning mixing operations. After the required amount of lime has been set by the Engineer, the rate shall not vary more than five percent.

(4) When directed to be used, calcium chloride shall be added during the mixing operation by an approved metering device, or by separate scales as required for cement, at the rate of

approximately 10 pounds {5 kg} per loose cubic yard {cubic meter} of mixture, based upon flake form. If other forms of calcium chloride are used, proportionate adjustment of rate of use and payment will be made. The amount of calcium chloride may be reduced or eliminated entirely as directed by the Engineer when weather conditions do not justify its use. No calcium chloride shall be added when cement is used.

(5) If other additives are specified, they shall be added as directed.

(6) The mixing plant shall not be operated at a speed or capacity that exceeds the manufacturer's rated capacity, established before mixing begins.

(7) After the plant has been set and calibrated, the Contractor shall give the Engineer sufficient notice in advance of starting operations, and shall make available sufficient skilled operators for checking the calibrations before actual start of operations. Materials and personnel used in checking the calibration shall be furnished without additional compensation.

(d) Placing of Base Materials.

1. General.

The operational procedure must be such that placement and processing of a layer will not damage the underlying layer or layers. Any material to be paid for by the cubic yard {cubic meter} shall be hauled in dump trucks whose volume may be readily determined. Premixed base and subbase materials shall be placed and spread by spreading equipment that will produce uniform layers of the required cross sections and thickness.

2. CEMENT TREATED BASES.

Cement treated bases and subbases shall be delivered and spread within 45 minutes after mixing. Mixtures containing cement that have not been shaped (except for final finishing) and compacted within three hours after mixing will be rejected and shall be removed promptly from the roadway and replaced at the Contractor's expense. For each base layer, the surface and thickness testing required in Article 301.05 shall be performed immediately upon compaction of the layer, and any variations from requirements shall be corrected immediately as specified in Article 301.05. All such base layers shall be kept moist enough for proper curing until covered by the next layer or the prime. The top layer shall be primed as soon as the compacting, shaping, thickness, and surface requirements have been met and in no case later than the next day after the surface is approved by the Engineer, unless weather conditions prevent. Prime shall be applied in accordance with Section 401, except that Item 401.03(b)2 will not apply.

Base material containing cement shall not be placed when the ground temperature in the shade is below 40 °F {4 °C}.

3. Lime Treated Bases.

Lime treated bases and subbases shall be delivered, spread, shaped, and compacted in the same day mixing occurs. Materials not compacted in the same day it is placed shall be reprocessed as directed at no additional cost to the State. Each base layer shall be tested for surface and thickness immediately after compaction in accordance with the provisions of Article 301.05 and any variations corrected as noted therein. The base layers shall be kept moist until covered by the next layer. Any cracking or other defects that may occur due to any cause or reason in any layer prior to being covered by the next plan layer shall be corrected immediately at no extra compensation.

Base materials containing lime shall not be placed where the ground temperature in the shade is below 40 °F {4 °C} unless authorized by the Engineer.

(e) Watering and Compaction.

Each layer of base and subbase shall be compacted to density as specified in Section 306. Where base and shoulder layers are constructed separately, the Contractor shall select and employ whatever method or procedure is necessary to produce required density at the edges of the base layers and to prevent lateral movement of the base material during compaction. Compaction tests will be made on each base layer, and each layer shall be brought to required density before the next layer is placed. Additional watering in connection with compaction will be required to obtain required density at a uniform moisture content within two percentage points of optimum as determined by the required laboratory test, except that the moisture content for crushed aggregate base layers shall be a minimum of five percent or as directed.

301.04 Shoulder Construction Requirements.

(a) General.

Shoulder construction requirements will be the same as provided for in Article 301.03 except as noted in this Article. Shoulders will be of two general types; standard or special design. Shoulder construction shall be so conducted that the base, shoulder, and adjacent side ditch will drain freely at all times. The shoulder slopes and ditches shall be dressed to reasonably close conformity to the designated lines, grades, and cross section.

(b) Standard Shoulders.

This type shoulder, where shown on the plans, shall be constructed by extending each subbase and base layer the full width from front slope to front slope in one operation. Materials and construction details for layers placed in the shoulder area will be the same as for base layers.

(c) Special Design Shoulders.

This type shoulder will consist of one or more layers of specified materials placed separately from the roadway base layers. This type shoulder may also include a drainage plane layer or a bituminous pavement or both. The composition and gradation of the materials and the width, thickness, and number of layers shall be as specified on the plans.

The sequence of the construction for the layers placed in the shoulder area will be at the option of the Contractor provided such will accomplish the desired results and is kept abreast of roadway base construction.

The drainage plane layer and the bituminous base and/or pavement shall be constructed in compliance with Section 315 and the appropriate Sections for the bituminous base or pavement.

The layers placed in the shoulder area shall be constructed in compliance with specifications for base layers of the same materials.

In spreading the next overlying layer of shoulder material on a drainage plane layer, special precaution shall be taken to prevent displacement of, or mixing with, the drainage plane material. This layer shall be placed by a spreader that will not touch or otherwise disturb the drainage plane layer. In order to accomplish the above, multiple passes will be permitted on wide shoulders. Placement of this layer shall be so controlled that not more than 2000 feet {600 m} of drainage plane material will remain uncovered at any time. Use of any equipment that might mix the shoulder material into the underlying drainage plane layer will not be permitted.

Layers placed in the shoulder area shall be compacted to the density specified in Section 306.

301.05 Sampling and Testing.

(a) General.

All sampling and testing, except in-place density, will be performed on the complete in-place base or subbase layers after final mixing and spreading on the roadway has been completed except as noted in Subarticle 301.05(c) for cement treated base material. In-place density will be performed on the layers after final shaping and compacting has been completed.

Any necessary sample holes, etc., required to satisfactorily establish the acceptability of any base layer shall be repaired by the Contractor immediately with like material. The cost of such repairs is considered to be incidental to the work and shall be performed without additional compensation.

(b) Surface Requirements.

The finished surface of each subbase or base layer shall not vary more than 1/2 of an inch {13 mm} in any 25 foot {8 meter} section from a taut string applied parallel to the surface and roadbed centerline at the following locations: 1 foot {300 mm} inside the edges of subbase or base, at the centerline, and at other points as designated. The finished surface shall not vary more than 3/8 of an inch {10 mm} from the required section measured with a template placed at right angles to the roadbed centerline. The template shall be of a rigid frame adjustable metal type, accurately set, and at least as long as the width of base layer being checked up to 24 feet {7.2 m}. Additional widths may be checked by the use of string and Engineer's level. The Contractor shall furnish template, string, and necessary personnel to handle same under the direction of the Engineer.

Where a Permeable Asphalt Treated Base (PATB) layer is to be placed (Pay Item 327-E), the finished base layer elevations shall not vary from design by more than 0.03 feet {10 mm} based on rod and level survey readings taken at a minimum of five locations across each lane (edge, outer wheel path, midlane, inner wheel path, and inside edge of lane) at longitudinal intervals not greater than 50 feet {15 m}.

Surface irregularities shall not exceed 1/4 inch {7 mm} between two points longitudinally or transversely using a 10-foot {3 m} straightedge.

(c) Gradation and Density.

Testing for compliance will be made as specified in Subarticle 301.05(a) except that a layer with a cement additive will require the pretesting of the blended components prior to the addition of the cement additive on the primary belt at the mixing plant.

The gradation of each layer will be checked at intervals as currently scheduled by the Department to determine compliance with the material specifications. Material falling outside of the specified bands of the general composition table shall be evaluated in accordance with the following: for each failing test, the price reduction will be five percent plus one percent for each percent for which the material failed to meet the required specifications. This applies to each sieve, percent clay, liquid limit (LL), or plasticity index (PI) requirement. These percentages are cumulative and apply to all material represented by that sample. If the resulting reduced unit price is less than 80% of the original unit price, the contractor will be given the option of modifying the in place material or removing and replacing the material. In either case, the gradation of the material will be re-tested for compliance with the material specifications.

The density of each layer will be checked at intervals as currently scheduled by the Department to verify compliance with specification requirements. Density requirements are specified in Section 306.

(d) Thickness.

The thickness of each layer will be checked at intervals as currently scheduled by the Department and at closer intervals if necessary to determine the limits of any section found to be outside of the tolerance limits.

1. For a layer placed under a "square yard " {"square meter"} item, the compacted thickness of the layer shall not be more than 1/2 of an inch {13 mm} less nor 1 inch {25 mm} more than the thickness specified on the plans or directed. A thickness greater than the 1 inch {25 mm} tolerance may be accepted if uniform over a sufficient length to not materially affect the riding surface or reduce any required clearances and is within surface smoothness tolerances specified in Subarticle 301.05(b).
2. For a layer placed under a "cubic yard" {"cubic meter"} item, the compacted thickness of the layer shall not exceed eight percent of each layer, plus or minus, of the designated thickness. Excess thickness above the eight percent noted above may be permitted to remain in place provided the riding surface is not affected and any required clearances are maintained, The excess material above the eight percent tolerance allowed will be deducted from the pay quantities.
3. If the base layer contains cement, areas below required thickness or elevation shall be corrected by increasing the thickness of the next layer; or for the top layer, the surface may be brought to proper elevation and thickness with layers of bituminous plant mix of appropriate gradation where the pavement is to be a bituminous type. These leveling layers shall be placed ahead of a plant mix pavement layer or after a liquid surface treatment layer, if any. These layers shall be placed without additional compensation, or the Contractor may at his option remove and replace the deficient areas at his own expense. Low areas in the subgrade under concrete pavement shall be corrected as specified under Subarticle 450.03(c).

(e) Width.

The widths shown on the plans, or directed, shall be the widths used for determining the area for pay purposes of square yard {square meter} layers. Widths in excess of the designated width may be acceptable if not detrimental to the appearance or design of the project; however, no deviation in excess of 0.3 feet {90 mm} less than the designated dimension for each side of a roadway will be acceptable.

301.06 Maintenance of the Work.

Each base layer shall be maintained as provided herein without extra compensation until it is covered by a succeeding layer or acceptance of the contract. The surface shall be kept free of ruts, ridges, holes, and substantially true to profile, grade, and cross-section. Each base layer must have the required density and moisture at the time it is covered by another layer. However, maintenance requirements for moisture will be waived for Crushed Aggregate Base after the layer has been properly

compacted with proper moisture content. No layer of base shall be covered by another layer or primed until it has been approved by the Engineer.

Special attention is directed to the fact that lime or cement treated bases require special care to insure proper curing. Daily watering, rolling, or maintenance of curing material is considered an integral part of the work until the treated layer is covered by another layer or completion of the contract.

The Engineer may re-test a primed base layer where he suspects that it does not have the required density and moisture. All areas found deficient shall be corrected by the Contractor, at his expense, prior to the placement of the next overlying layer.

It shall be the Contractor's responsibility to protect the base from damage and to protect the prime from being picked up or damaged by traffic and to replace promptly any base or prime so damaged.

301.07 Method of Measurement.

(a) Base Materials.

Measurement of base materials will be made in accordance with the particular item provided in the contract in accordance with the following:

1. Square Yards {Square Meters}.

Measurement by the square yard {square meter} will be made of a completed accepted layer of base constructed to the thickness and cross section shown on the plans or directed. All calculations of areas for payment shall be based on computations made to the nearest 0.1 of a square yard {0.1 square meter}. The length will be measured along the surface of the layer at the centerline of the roadbed to the nearest 0.1 of a foot {0.1 m}. For transitions in thickness, the thickness will be measured to the midpoint of the transition. The width will be the top surface width of the layer as specified on the plans or directed. Each layer of crossovers, turnouts, and the like will be measured in square yards {square meters} by lengths and widths along the top surface of the layer involved. No measurement will be made for the necessary bevel or wedge of material shown on the plans along the edge of each layer.

Where the Engineer directs in writing that the thickness of a layer be changed from that specified on the plans, the accepted layer shall have an adjusted unit price derived by arriving at an increase or decrease to the contract unit price bid in direct proportion to the increased or decreased thickness of the adjusted layer. No payment shall be made for a layer completely eliminated.

2. Cubic Yards {Cubic Meters}.

Measurement by the cubic yard {cubic meter} will be the loose volume of the material measured in the hauling vehicle at the point of use.

3. Tons {Metric Tons}.

Measurement by the ton {metric ton} will be the quantity of material placed in a completed accepted layer of base constructed to the thickness and cross section shown on the plans or directed and measured in accordance with the provisions of Subarticle 109.01(h).

(b) Cement.

Measurement of cement will be by the ton {metric ton} for cement actually used in the work as directed, except cement used to repair or replace defective work.

(c) Lime.

Measurement of lime will be by the ton {metric ton} for lime actually used in the work as directed, except for lime used to repair or replace defective work.

301.08 Basis of Payment.

(a) Unit Price Coverage.

1. The contract unit price bid shall be full compensation for furnishing or producing all component material, except cement and lime, in whatever proportions necessary to produce and place the base material, in accordance with the requirements specified, complete in place on the roadbed. It includes all costs for procurement, operations, compaction, watering, equipment, tools, labor, and incidentals necessary to complete the work. Cement and lime used as directed, in completed and accepted layers, will be the only other item for which separate payment will be made under this Section.

2. Payment for cement and lime, measured as noted above, will be at the contract unit price per ton {metric ton}. This payment shall be payment in full for furnishing and incorporating the cement and lime into the base material.

(b) Price Adjustments.

When layers failing to meet the gradation band requirements are permitted to remain in place as specified in Subarticle 301.05(c), unit price adjustments will be made as specified therein.

(c) Payment will be made under Item No.:

301-A __*__ __t__ Course, Type __tt__, __**__, __ttt__ Mixed, ____ inches {mm} Compacted Thickness - per square yard {square meter}
301-B __*__ __t__ Course, Type __tt__, __**__, __ttt__ Mixed, - per cubic yard {cubic meter}
301-C Cement - per ton {metric ton}
301-D Lime - per ton {metric ton}
301-E __*__ __t__ Course, Type __tt__, __**__, __ttt__ Mixed, - per ton {metric ton}

* Base Classification (Selected Materials, etc., Granular Soil, Soil Aggregate, Processed Reef Shell, Crushed Aggregate)
t Base or Subbase
tt Type
** Insert "with cement or lime additive," if required
ttt Road, Yard, or Plant

SECTION 302
FULL DEPTH RECLAMATION WITH PORTLAND CEMENT

302.01 Description.

Full Depth Reclamation with Portland cement shall consist of pulverizing and mixing the in place existing materials as shown in the plans with Portland cement and water to produce a uniform mixture and then compacting the mixture to serve as a base course for pavement.

302.02 Materials.

(a) Cement.

Cement shall meet the requirements given in Section 815 "Cement" for Type I or Type II Portland Cement.

(b) Water.

Water shall meet the requirements given in Section 807.

302.03 Construction Requirements.

(a) Offset Reference for the Establishment of the Roadway Alignment.

The Contractor shall establish offset reference points before beginning of construction so that the original alignment of the roadway (centerlines, edges of pavement, etc.) will be restored during construction.

(b) Job Mix Design.

A "Job Mix Design" is a listing of all components of the mixture required for the full depth reclamation. If a Job Mix Design is shown on the plans the Contractor shall use that mix design for the full depth reclamation work. If a Job Mix Design is not shown on the plans the Contractor shall determine the composition of the Job Mix Design and submit it to the Engineer for review. The Engineer will forward the proposed Job Mix Design to the Materials and Tests Engineer for approval.

Job Mix Designs shown on the plans and submitted Job Mix Designs approved by the Materials and Tests Engineer shall not be changed without written approval of the Engineer. The Contractor shall submit the proposed changes to the Engineer with an analysis of the need for the change. The Engineer will forward the proposed change to the Materials and Tests Engineer for approval.

(c) Submittal of a Proposed Job Mix Design by the Contractor.

The Contractor shall submit a proposed Job Mix Design no later than 21 Calendar Days after the date of Notice to Proceed. The Department will be allowed 21 Calendar Days to complete the verification and approval of the Job Mix design. The composition of a Job Mix Design submitted by the Contractor shall be established in accordance with the requirements given in ALDOT 416, "Laboratory Design of Soil-Cement and Full-Depth Reclamation Mixes". More than one Job Mix Design may be required due to the variability of the existing roadbed materials. Each proposed Job Mix Design and samples of the roadbed materials for each design shall be submitted for evaluation and approval.

The Contractor shall submit five copies of each proposed Job Mix Design to the Materials and Tests Engineer for approval. . All of the requirements given in ALDOT 416 shall be addressed in the Contractor's submittal of the Job Mix Designs. Construction of full depth reclamation shall not begin until the Engineer returns a copy of each approved Job Mix Design to the Contractor.

The Contractor shall submit 75 pounds of composite representative samples of the existing roadbed materials and 5 pounds of the cement proposed for each proposed Job Mix Design. The Contractor shall sample the existing roadbed materials at least every 1000 feet along the roadbed. Samples shall be obtained from all layers to be reclaimed. These materials shall be submitted to the Materials and Tests Engineer with the Job Mix Design submittal.

(d) Quality Control.

The Contractor shall provide and maintain a quality control system to provide assurance that the full depth reclamation is constructed in accordance with the contract requirements.

The Contractor shall submit six copies of a "Quality Control Plan for Full Depth Reclamation" to the Engineer for review prior to the preconstruction conference. This plan shall include the following minimum requirements:

- The procedure, equipment, and frequency for monitoring the amount of cement placement.
- The procedure, equipment, and frequency for monitoring the material characteristics of the reclaimed material.
- The procedure, equipment, and frequency for monitoring the amount of water, and depth of pulverization of the reclaimed material during mixing.
- The procedure, equipment and frequency for monitoring the reclaimed material moisture during production.
- The procedure, equipment and frequency for monitoring the density and moisture content of the in-place full depth reclamation.
- List of all equipment to be used during the construction of full depth reclamation.
- Production rates.
- The procedure for correcting problems such as equipment breakdown, weather related failures, and poor workmanship as determined by the Engineer
- The procedure and equipment for repairing full depth reclamation no meeting the project requirements.
- Other information requested by the Engineer during the Pre-Construction conference.

The Contractor shall present weekly documentation to the Engineer that the work is being monitored in accordance with the requirements given in the quality control plan.

The Engineer will not approve the Contractor's "Quality Control Plan for Full Depth Reclamation" but will review it for completeness. An incomplete plan will be returned to the Contractor. Construction shall not begin until the Engineer returns one copy of the plan to the Contractor and informs the Contractor in writing that no further information will be required. The Engineer will stop the production of full depth reclamation if the Contractor does not perform the work in accordance with the submitted plan.

(e) Weather Limitations.

All full depth reclamation operations including pulverizing, mixing, compaction, finishing, and curing shall be continuous and completed during daylight hours.

No full depth reclamation shall be constructed when the ambient temperature is below 40 ºF without written permission of the Engineer.

Working on full depth reclamation construction will not be allowed when it is raining or the possibility or rain is imminent. The Engineer will decide base on weather reports if the possibility of rain exists.

(f) Equipment.

The Engineer will prohibit the use of any piece of equipment that will not, or does not, produce acceptable results.

The Contractor shall not begin the distribution of the cement until the Engineer informs the Contractor that the proposed equipment and method of monitoring cement placement is adequately described in the quality control plan.

Equipment shall include a mechanical cement spreader of a type that has an adjustable rate of flow and will distribute the cement uniformly at the required rate in one pass. Pneumatic distribution of cement is prohibited.

A mechanical mixer shall be used that is capable of pulverizing and mixing the existing pavement, base and sub-grade to the required depth. The mechanical mixer shall be capable of pulverizing the material so that 100 % passes a 2 inch sieve. The mixer shall have a metered water system for adding water directly into the mixing chamber. Water shall not be applied from equipment that is not a part of the mixer.

(g) Length of Roadbed Allowed to be Processed.

Except by written permission of the Engineer, the length of roadbed pulverized at any time shall not exceed the length that can be completely pulverized, mixed and compacted in the same working day.

(h) Initial Pulverizing and Mixing.

The width and depth of the required pulverizing and mixing will be shown on the plans. The depth of pulverizing shall be controlled to insure that the finished thickness will be within the required tolerance limits.

The pulverizing and mixing shall break up the existing roadbed to the extent that 100 % by weight passes a 3 inch sieve, a minimum of 95 % passes a 2 inch sieve and a minimum of 50 % passes the No. 4 sieve. The moisture content shall be maintained within ± 2 % of the theoretical optimum moisture content unless approved otherwise by the Engineer.

The Engineer will check the gradation at least once for each 2000 linear feet or fraction thereof of each lane. Preliminary pulverization and mixing of the roadbed materials will be allowed prior to final pulverization and mixing of the roadbed materials and cement to ensure uniformity of the mixture. The Engineer will monitor the pulverization in accordance with BMT-80, “Rate of Spread and Pulverization of Cement Stabilized Soil”.

(i) Spreading of Cement.

Spreading of the cement shall be done to produce a uniform distribution. The amount of cement placed shall not vary more than 5 % by weight from the approved Job Mix Design.

Cement dust shall be controlled by the Contractor so that dust is kept within the confines of the construction limits. Spreading of the cement when the wind or other weather conditions are unfavorable will not be permitted. Spreading of the cement by motor grader will not be acceptable.

Cement shall be applied in a limited area so that all the operations including compaction, finishing, and curing can be continuous and completed in daylight hours, within three hours of the application of the cement.

Only the equipment that is used in spreading and mixing will be allowed to pass over the spread cement before it is mixed into the existing materials. Cement that has been displaced shall be replaced before mixing is started.

(j) Mixing Water with Cement and Pulverized Materials.

Water shall be mixed into the mixture of cement and pulverized roadbed materials. The addition of water and the mixing shall be completed in one continuous pass. The mixture of the water, cement, and pulverized roadbed materials shall be within the tolerance limits of theoretical optimum moisture content and shall be suitable for immediate compaction without further mixing or grading.

A gage or gages shall be provided to allow the continuous monitoring of the amount of water that is applied.

When the mixer will handle only a part of the roadbed width within a single lane, the successive increments shall be limited in length so that a cold joint will not be formed within the lane being constructed and the full width of lane of treated material will be promptly mixed, compacted, and finished.

When the moisture content of the uncompacted mixture exceeds the specified tolerance for compaction, the entire affected section shall be reconstructed at the Contractor’s expense.

(k) Compaction and Finishing.

The pulverizing, mixing, and compaction shall be a continuous operation. The compaction of the mixture of water, cement, and roadbed materials shall begin within 30 minutes after the final mixing. The mixture shall be compacted to 96.0% of theoretical maximum density as established in the approved Job Mix Design in accordance with AASHTO T 134. The in-place density will be measured in accordance with the requirements given in AASHTO T 310, Direct Transmission Method only. The in-place density

will be measured at least once for each 1000 linear feet or fraction thereof of each lane. Compaction and finishing shall be completed within a period of two hours after the initial mixing of the cement.

After the mixture has been compacted, the surface shall be shaped to the required lines, grades, and cross sections and within the required tolerances. During the shaping, light scarifying may be necessary to prevent the formation of compaction planes. Broom dragging or clipping of the surface may be required as a part of the process of shaping the surface during compaction. The surface material shall be maintained at the specified moisture content during finishing operations.

At the end of each day's construction, a clean, straight, vertical, transverse construction joint shall be formed by cutting back to the full width and thickness of completed work.

(l) Testing, Tolerance, and Deficiency Correction.

1. General.

Areas of the full depth reclamation that are not within the required tolerances of thickness, density, and surface finish shall be reconstructed as directed by the Engineer without additional compensation. The amount of cement required for reconstruction will be in accordance with the approved Job Mix Design.

2. Cement Spread Rate.

The Contractor shall furnish and use a square piece of canvas that is one square yard in size for checking the spread rate. The canvas shall be weighed prior to cement placement each time placement rates are checked. After weighing, the canvas shall be placed ahead of the spreading operation. The canvas and cement shall be weighed after the spreader has passed over the canvas. The Contractor shall perform this measurement in the presence of the Engineer and report the measured spread rate to the Engineer. Adjustments shall be made and repeated testing will be required to insure that the required rate is being placed.

The cement spread rate shall be checked each day before beginning production placement and for each 2000 linear feet or fraction thereof of spreading in each lane.

The Engineer will record the amount of cement placed in accordance with BMT-80, "Rate of Spread and Pulverization of Cement Stabilized Soil".

3. Thickness.

The thickness of the reconstructed roadbed will be checked by the Engineer at intervals of one test per 200 feet or fraction thereof of lane, or more often if necessary. The thickness of the entire reconstructed layer or layers shall not vary by ± 1 inch from that shown on the plans. Any section deficient by more than 1 inch shall be immediately reconstructed in accordance with all of the requirements given in this Section for full depth reclamation. Any section out of tolerance shall have additional cement added to correct the composition of the full depth reclamation mixture and shall be remixed and recompacted to the required depth, width and density.

4. Surface Finish.

The Contractor shall be responsible for roadbed grade controls. The finished surface shall not vary more than 1/4 of an inch from a 16 foot straightedge placed anywhere on the surface parallel to the centerline of the roadbed. The finished surface shall not vary more than ¼ of an inch from a 10 foot straightedge placed anywhere on the surface perpendicular to the centerline of the roadbed.

The cross slope shall not vary by ± 0.50 % from the required slope as shown on the plans.

The surface finish shall be checked at least twice within an intervals not to exceed 100 feet along the roadway. High spots in the finished surface may be corrected by motor grader or planer without additional compensation, provided the resulting thickness is within the allowable tolerances.

(m) Curing.

The Contractor shall cover the finished surface with a prime coat within 24 hours from completion of compaction. The prime coat shall be maintained until a pavement layer or additional surface treatment is applied. The prime coat shall be as specified in the plans and shall be placed and paid in accordance with the requirements given in Section 401.

(n) Workmanship.

Any subgrade deficiencies shall be determined by the Engineer. The Contractor will be given a specific time to repair any deficiencies without any additional compensation.

(o) Opening to Traffic.

Completed sections of the full depth reclaimed roadbed may be opened when necessary to lightweight local traffic, provided the surface has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Construction equipment shall not operate on

the full depth reclamation sections except as necessary to discharge into the spreader during paving operations. If the full depth reclaimed roadbed is impaired by premature opening to traffic, the entire affected section shall be reconstructed at the Contractor's expense.

302.04 Method of Measurement.

Full Depth Reclamation will be measured in units of square yards. The length of a lane will be measured along the center of the lane. The width of a lane will be the width shown on the plans. Additional areas required for crossovers, turnouts, etc., will be determined by the measurement of the length and width along the surface of the reclaimed area.

Cement will be measured in units of tons.

302.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for Full Depth Reclamation shall be full compensation for furnishing all materials (except Portland cement and Bituminous Treatment for curing) equipment, tools, labor, and incidentals necessary to complete the work.

The contract unit price for Portland cement for Roadbed Reclamation shall be full compensation for furnishing and applying the cement to complete the work of Full Depth Reclamation. Payment will only be made for the actual amount of cement applied to the reclaimed roadbed.

Additional soil or aggregate material required to construct the roadbed to the required plan grade and section, and any unsuitable material excavated, will be measured and paid for under the appropriate item of Unclassified Excavation or Borrow.

(b) Payment will be made under Item No.:

302-A Full Depth Reclamation, ___ inches Thick- per square yard
302-B Portland Cement for Full Depth Reclamation - per ton

SECTION 305
SOIL AND AGGREGATE MATERIALS FOR MISCELLANEOUS USE

305.01 Description.

This Section shall cover the work of furnishing and incorporating a soil or aggregate material of the type specified into the work at the locations shown on the plans or designated by the Engineer.

The type material may be a local material, such as borrow or selected soil, or commercial material, such as crushed aggregate, or any combination thereof to produce a material consistent with the requirements of the type material specified.

The intent of this Section is to provide a material for use in localized areas for patching, leveling, or minor widening work.

Layers of material of a nominal depth and width should be placed under the appropriate Section of the Standard Specifications.

305.02 Materials.

All materials furnished for use shall comply with the requirements of the appropriate sections of the Standard Specifications, except as modified by the plans or proposal. Special attention is directed to Sections 210 and 820 through 825.

305.03 Construction Requirements.

(a) General.

The work of placing the material in this Section includes surface preparation including the scarification of the existing material, the addition of the material, and the processing of the new material with the existing material to form an installation meeting plan requirements.

(b) Surface Preparation.

Surface preparation shall include any work necessary to clean the surface of the area on which the new material is to be placed, along with scarifying the surface of the existing material to promote an acceptable bond of the new and old material.

(c) Placing of the Material.

The material shall be placed, spread, and incorporated into the work at the locations shown on the plans or directed. The new material shall be mixed with the old material to the extent necessary to provide for an acceptable bond between the new and old material.

Strict moisture and density controls will not be required; however, the material shall be mixed and compacted to the satisfaction of the Engineer.

305.04 Method of Measurement.

The quantity of material placed will be measured in cubic yards {cubic meters} in accordance with the provisions of Subarticle 109.01(i) or per ton {metric ton} measured in accordance with the provisions of Subarticle 109.01(h).

305.05 Basis of Payment.

(a) Unit Price Coverage.

Aggregate material ordered and accepted, measured as noted above, will be paid for at the contract unit price bid for each type material which shall be full compensation for the material complete in place and includes all costs incident to furnishing and producing the material, all hauling, surface preparation, spreading, mixing, watering, compacting, and shaping and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

305-A ___*, ___**, for Miscellaneous Use - per cubic yard {cubic meter}
305-B ___*, ___**, for Miscellaneous Use - per ton {metric ton}

* Kind of material:

Borrow, Section 210
Coarse Aggregate, Section 801
Selected Materials, Section 820
Granular Soil, Section 821
Drainage Plane, Section 822
Soil Aggregate, Section 823
Processed Reef Shell, Section 824
Crushed Aggregate, Section 825

** Type of material, if specified

SECTION 306
DENSITY REQUIREMENTS FOR COMPACTION

306.01 Description.

The density requirements for earth work, subbase, base, shoulders, surface, and pavement layers are given in this Section. Compensation for obtaining the required densities shall be included in the contract price for the material being compacted.

This Section shall also cover the work of furnishing a Portable Nuclear Moisture-Density Testing Device ("Nuclear Testing Device") for use by Department personnel.

306.02 Materials.

(a) Materials subject to Compaction Requirements.

The compaction requirements given in this Section shall be applicable to materials required to be furnished under other Sections when a reference to the compaction requirements is given in those Sections.

(b) Non-Destructive Testing Devices.

1. Utilization of Non-Destructive Testing Devices.

Non-destructive density testing of Hot Mix Asphalt (HMA) will be allowed for "quality control testing" purposes only and will not be used for acceptance testing. All acceptance density testing of HMA will be done by coring the pavement (AASHTO T 166).

2. Nuclear Testing Device.

The Department has established a list of acceptable nuclear testing devices. Devices that are not shown on this list shall not be used. The list is List II-21, "Nuclear Testing Devices" and is given in the Department's manual, "MATERIAL, SOURCES AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS." Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

3. Electronic Surface Contact Device.

An electronic surface contact device will be allowed for the measurement of the density of hot mix asphalt (HMA) pavement layers.

The test method and apparatus described in AASHTO TP 68-04 (2008), "Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices", Method C (Core Calibration Method), shall be used for this testing.

306.03 Construction Requirements.

(a) Contractor's Responsibility for Compaction.

The materials (soils, hot mix asphalt) selected by the Contractor will be sampled and tested to establish the density requirements for compaction. The Contractor shall compact the materials to the required density.

In place density will be measured for acceptance in accordance with the requirements given in AASHTO T 310, "In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)", Direct Transmission Method only as modified by the following method:

- A probe access pivot hole is required for the direct transmission method. Moisture and density counts shall be obtained by taking two "one minute" readings with each reading being performed at a 180 ° interval from the prior reading. The moisture and density reading shall be the average of the results of the two counts.
- The surface under the gauge shall be examined to make sure that it is flat and level and that the access pivot hole is perpendicular to the base plane before placing the density gauge over the pivot hole.
- The first one-minute reading of moisture and density counts shall be taken and recorded.
- The gage shall then be rotated 180°over same center point and the second one-minute reading of moisture and density counts shall be taken and recorded.
- All measurement counts shall be repeated if any count is not within a range of values set by an upper limit that is the average plus five times the square root of the average and a lower limit that is the average minus five times the square root of the average.

(b) Embankment Layers.

1. Determination of Maximum Density and Optimum Moisture Content.

The maximum density and optimum moisture content for the compaction of materials for embankments will be determined in accordance with the test methods given in AASHTO T 99 "Moisture-Density of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 inch) Drop".

Method A will be used when 10 % or less of the embankment material is retained on the Number 4 {4.75 mm} sieve.

Method C will be used when more than 10 % is retained on the Number 4 {4.75 mm} sieve, and less than 20 % is retained on the 3/4 inch {19.0 mm} sieve.

Method D will be used when 20 % or more is retained on the 3/4 inch {19.0 mm} sieve.

2. Required In-Place Density.

The Contractor shall compact the embankment layers to within 95 % of the maximum density. The in-place density will be measured in accordance with the requirements given in Subarticle 306.03(a).

There will not be a measurement of the in-place density of embankment layers that are composed predominantly of rock (approximately 70 % or greater). These layers shall be rolled until firm as determined by the Engineer.

3. Required Moisture Content.

Strict moisture control will not be required. Compaction in a semi-dry condition will not be permitted.

(c) Modified and Improved Roadbed Layers.

1. Determination of Maximum Density and Optimum Moisture Content.

The maximum density and optimum moisture content for the compaction of materials for modified and improved roadbed layers will be determined in accordance with the test methods given in AASHTO T 99.

Method A will be used when 10 % or less of the modified and improved roadbed material is retained on the Number 4 {4.75 mm} sieve.

Method C will be used when more than 10 % is retained on the Number 4 {4.75 mm} sieve, and less than 20 % is retained on the 3/4 inch {19.0 mm} sieve.

Method D will be used when 20 % or more is retained on the 3/4 inch {19.0 mm} sieve.

2. Required In-Place Density.

The Contractor shall compact the modified and improved roadbed layers to 100 % of the maximum density. The in-place density will be measured for acceptance in accordance with the requirements given in 306.03(a).

3. Required Moisture Content.

The moisture content during compaction shall be within ± 2 % of the optimum moisture content.

(d) Roadbed or Lime Stabilization.

1. Determination of Maximum Density and Optimum Moisture Content.

The maximum density and optimum moisture content for the compaction of materials selected for the construction of a roadbed utilizing materials without lime additive will be determined in accordance with the test methods given in AASHTO T 99.

The test methods given in ALDOT-223, “Establishing Moisture-Density Controls for Soils and/or Aggregates with Chemical Additives (Excluding Bituminous Materials)”, will be used for lime stabilized roadbeds.

Method A will be used when 10 % or less of the modified and improved roadbed material is retained on the Number 4 {4.75 mm} sieve.

Method C will be used when more than 10 % is retained on the Number 4 {4.75 mm} sieve, and less than 20 % is retained on the 3/4 inch {19.0 mm} sieve.

Method D will be used when 20 % or more is retained on the 3/4 inch {19.0 mm} sieve.

2. Required In-Place Density.

The Contractor shall compact the roadbed or lime stabilized layers to 100 % of the maximum density. The in-place density will be measured for acceptance in accordance with the requirements given in Subarticle 306.03(a).

3. Required Moisture Content.

The moisture content during compaction shall be within ± 5 % of the optimum moisture content.

(e) Subbase and Base Layers.

1. Determination of Maximum Density and Optimum Moisture Content.

a. Materials Containing Natural Soil Binders without Chemical Additives.

The maximum density and optimum moisture content will be determined in accordance with the test methods given in AASHTO T 180 "Moisture-Density of Soils Using a 4.54-kg (10-lb) Rammer and a 467-mm (18-in.) Drop".

Method A will be used when 10 % or less of the modified and improved roadbed material is retained on the Number 4 {4.75 mm} sieve.

Method C will be used when more than 10 % is retained on the Number 4 {4.75 mm} sieve, and less than 20 % is retained on the 3/4 inch {19.0 mm} sieve.

Method D will be used when 20 % or more is retained on the 3/4 inch {19.0 mm} sieve.

b. Materials Containing Natural Soil Binders With Portland Cement, Calcium Chloride or Other Chemical Additives, Excluding Bituminous Materials.

The maximum density and optimum moisture content will be determined in accordance with the requirements given in ALDOT-223.

c. Materials Composed of All Crushed Aggregates With or Without Chemical Additives, Excluding Bituminous Materials.

The maximum density and optimum moisture content will be determined in accordance with the requirements given in AASHTO T 180 for Method D or ALDOT-140.

d. Bituminous Mixtures.

The maximum density will be determined in accordance with the requirements given in AASHTO T 209, "Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures".

e. All Soil or Aggregate Base Layers, With or Without Chemical Additives, Excluding Bituminous Materials - CONTROL STRIP METHOD.

The CONTROL STRIP METHOD may be allowed for establishing a target maximum density and target optimal moisture if allowed in writing by the Engineer. The target maximum density and optimum moisture content shall be determined in accordance with the requirements given in ALDOT-225, “Construction of Moisture-Density Control Strips for Soil and/or Aggregate Base Layers”.

2. Required In-Place Density.

a. Materials Containing Natural Soil Binders without Chemical Additives.

The Contractor shall compact the materials to within 95 % of the maximum density for Method A, and to 100 % of maximum density for Methods C and D (AASHTO T 180). The in-place density will be measured in accordance with the requirements given in Subarticle 306.03(a).

b. Materials Containing Natural Soil Binders With Portland Cement, Calcium Chloride or Other Chemical Additives, Excluding Bituminous Materials.

The Contractor shall compact the materials to within 98 % of the maximum density measured using Method A of ALDOT-223, and to 100 % of maximum density measured using Method B of ALDOT-223. The in-place density will be measured in accordance with the requirements given in Subarticle 306.03(a).

c. Materials Composed of All Crushed Aggregates With or Without Chemical Additives, Excluding Bituminous Materials.

The Contractor shall compact the roadbed or lime stabilized layers to 100 % of the maximum density determined in accordance with the requirements given in AASHTO T 180 for Method D or ALDOT-140. The in-place density will be measured in accordance with the requirements given in Subarticle 306.03(a).

d. Bituminous Mixtures.

The Contractor shall compact the bituminous mixtures to the density that is given in Section 410. The in-place density will be measured for acceptance in accordance with the requirements given in AASHTO T 166.

e. All Soil or Aggregate Base Layers, With or Without Chemical Additives, Excluding Bituminous Materials - CONTROL STRIP METHOD.

The Contractor shall compact the roadbed or lime stabilized layers to 100 % of the maximum density (ALDOT-225). The in-place density will be measured in accordance with the requirements given in Subarticle 306.03(a).

3. Required Moisture Content.

Moisture content during compaction shall be within ± 2 % of the optimum moisture content. This moisture content requirement shall not apply to bituminous materials for base and subbase.

4. Control Strip for Soil and Aggregate Layers Only.

The CONTROL STRIP METHOD, ALDOT-225, shall only be used for soil and aggregate layers. It shall only be used if it is shown to be required in the contract or if it is requested by the Contractor and allowed by the Engineer.

The Contractor shall make a substantial effort to achieve the required density prior to requesting a control strip.

The request for a control strip shall be submitted by the Contractor to the Engineer in writing. The Engineer will forward this request to the Materials and Tests Engineer for approval. The written request shall include a description of the efforts made to achieve the required density. The description shall include the types, size, settings of rollers, rolling patterns for each roller and the results of compaction for each roller. The description shall also include all results of laboratory and field testing (soil analysis, maximum density, optimum moisture content, actual densities and moisture contents). Any other pertinent information concerning the material, other equipment used, and actions taken in an effort to achieve the required density shall be included.

Each control strip, constructed to acceptable density and surface tolerances, shall remain in place and become a section of the completed roadway. Unacceptable control strips shall be corrected or removed and replaced at the Contractor's expense.

The cost of the construction of the control strip is considered incidental to the testing method and shall be done without extra compensation.

(f) Blank.

(g) Density For Bituminous Pavement Layers.

1. Determination of Maximum Theoretical Density.

The maximum theoretical density will be determined in accordance with the requirements given in AASHTO T 209.

2. Required In-Place Density and Determination of In-Place Density.

The required in-place density is given in Section 410. The in-place density will be measured for acceptance in accordance with the requirements given in AASHTO T 166.

3. Density of Layers Placed on Bituminous Surface Treatment.

For layers that are placed on bituminous surface treatment, the achievement of a designated percentage of the maximum theoretical density will not be required when the designated placement rates are 139 pounds or less per square yard {75 kg or less per square meter}. These layers shall be thoroughly compacted as directed by the Engineer.

A reduced density requirement will be allowed for layers that are placed on bituminous surface treatment at designated placement rates of 140 pounds per square yard or greater {76 kg per square meter or greater} and less than 200 pounds per square yard {109 kg per square meter}. The allowable reduction in density is given in the Acceptance Schedule of Payment for In-Place Density (Table IV) given in Section 410.

4. Density of Layers not placed on Bituminous Surface Treatment.

For layers that are not placed on a bituminous surface treatment, the achievement of a designated percentage of the maximum theoretical density will not be required when the designated placement rate is 124 pounds or less per square yard {67 kg or less per square meter}. These layers shall be thoroughly compacted as directed by the Engineer.

(h) Portable Nuclear Moisture-Density Testing Device.

1. Contractor Furnished Nuclear Testing Device.

The Contractor may be required to furnish a nuclear moisture-density testing device or recondition a device for use by ALDOT personnel. This will be required if a pay item for a nuclear testing device is a part of the contract.

2. Radiological Safety Manual.

The operation of the nuclear moisture-density testing device shall be in accordance with the requirements given in the ALDOT "RADIOLOGICAL SAFETY MANUAL FOR THE USE OF NUCLEAR MOISTURE/DENSITY AND ASPHALT CONTENT GAUGES".

3. License for Owning Radioactive Materials.

The Alabama State Department of Public Health requires a license for owning radioactive materials. A nuclear testing device will not be returned to the Contractor (when returning the device is a contract requirement) until the Contractor obtains this license.

4. Service Warranty for Contractor Furnished Device (New and Reconditioned).

The Contractor shall provide a Service Warranty from the manufacturer of the nuclear testing device, or an authorized service center, for parts and services required for the continuous serviceability of the device furnished by the Contractor. A Service Warranty shall be furnished for all devices, new or reconditioned. The Service Warranty shall not be voided by ALDOT employees removing, repairing, and exchanging modules.

5. Inoperable Contractor Furnished Nuclear Testing Device.

The Contractor shall be responsible for all delays to the prosecution of the work that are due to a malfunctioning device that was furnished by the Contractor. This responsibility extends to all devices, new or reconditioned.

The Engineer will order the replacement of a continually malfunctioning device. The contract price for a Contractor furnished device will be reduced by a prorated amount that is calculated from the amount of time that the Contractor furnished device is inoperable.

The Contractor shall immediately replace a malfunctioning nuclear testing device without extra compensation when the work is delayed because of the malfunction. The compensation for the device will be reduced by a percentage amount calculated from the number of days that the device was not suitable for use and the total number of days in the contract.

6. Serviceability and Ownership of Contractor Furnished Nuclear Testing Device.

The final ownership of the nuclear testing device will be based on the requirements given for the Pay Item for the device. When the Engineer determines that the device is no longer needed it shall be transferred to the Department, or the Contractor will be notified by certified letter to pick up the device.

The Contractor shall retain ownership of a device if the device is furnished under Pay Item 306-A, "Portable Nuclear Moisture-Density Testing Device".

The Contractor shall retain ownership of a device for the duration of the need of the device if it is furnished under Pay Item 306-B, "State Retained Portable Nuclear Moisture-Density Testing Device". This device shall be a new Nuclear Moisture-Density Testing Device. When the device is no longer needed the Contractor shall be responsible for the reconditioning, verification, and, if necessary, recalibration of the device and the transfer of device and title of ownership to the Department.

The Contractor shall retain ownership of a device for the duration of the need of the device if it is furnished under Pay Item 306-E, "State Retained Portable Nuclear Moisture-Density Testing Device (Includes Disposal of Existing Device)". This device furnished by the Contractor shall be a new Nuclear Moisture-Density Testing Device. When the device is no longer needed, the Contractor shall be responsible for the reconditioning, verification, and, if necessary, recalibration of the device and the transfer of device and title of ownership to the Department. A Department owned device will be designated for disposal. The Contractor shall take ownership of the device designated for disposal and shall pick up the device at the ALDOT Central Laboratory. The Department will pack the device and have it ready for transport. The title of ownership will be transferred to the Contractor. Transfer of the device will be in accordance with Health Department regulations and under no circumstances will a nuclear device be transferred to an unlicensed agent or company.

If the Contractor is required to take possession of a device that is not designated for disposal, 30 calendar days will be allowed from the date of the notification for the Contractor to present a valid license for owning radioactive material from the Alabama State Department of Public Health and then obtain possession of the device. The device shall become ALDOT property and the title of ownership shall be transferred to the ALDOT if the Contractor fails to present the proper license and obtain possession of the device within the 30 calendar days.

306.04 Method of Measurement.

Nuclear Testing Devices will be measured per each device.

306.05 Basis of Payment.

(a) Compaction.

Separate payment will not be made for the work of compaction to meet the density requirements given in this Section. This work shall be incidental to the requirements of the placement of the material for which density requirements are given.

(b) Portable Nuclear Moisture-Density Testing Device.

1. Pay Item 306-A, Portable Nuclear Moisture-Density Testing Device.

The contract price for a device shall be full compensation for the furnishing of the device with all required accessories and services. This contract price shall be for exclusive use of the device for the duration of the contract or until Engineer determines that there will be no further need for the device.

2. Pay Item 306-B, State Retained Portable Nuclear Moisture-Density Testing Device.

The contract price for a device shall be full compensation for the furnishing of the device with all required accessories and services and for the exclusive use of the device by the Department. The contract price shall also be full compensation for the maintenance of the device, the reconditioning, verification, and, if necessary, recalibration and transfer of the device and title of ownership to the Department.

3. Pay Item 306-E, State Retained Portable Nuclear Moisture-Density Testing Device (Includes Disposal Of Existing Device).

The contract price for a device shall be full compensation for the furnishing of the device with all required accessories and services and for the exclusive use of the device by the Department. The contract price shall also be full compensation for the maintenance of the device, the reconditioning, verification, and, if necessary, recalibration and transfer of the device and title of ownership to the Department.

The contract price shall also be full compensation for the Contractor to take ownership of a device designated for disposal by the Department and full compensation for the costs of obtaining, transporting and disposing the device.

(c) Payment will be made under Item No.:

306-A Portable Nuclear Moisture-Density Testing Device - per each
306-B State Retained Portable Nuclear Moisture-Density Testing Device - per each
306-E State Retained Portable Nuclear Moisture-Density Testing Device (Includes Disposal of Existing Device) - per each

SECTION 315
DRAINAGE PLANE LAYER

315.01 Description.

This Section shall cover the work of constructing a drainage plane layer composed of an approved free-draining material.

This layer normally is used to facilitate drainage from the pavement structure layer through the shoulders; however, it may be used at other locations when shown on the plans or directed.

315.02 Materials.

Materials for use shall meet the appropriate requirements of Division 800, Materials, with specific reference to Section 822.

315.03 Construction Requirements.

The drainage layer shall be constructed in reasonably close conformity to the cross sections and dimensions shown on the plans and in the sequence noted in Subarticle 301.04(c). The thickness shown on the plans will be loose measurement before covering with another layer.

The drainage plane materials shall be spread by approved equipment capable of providing a single layer of uniform thickness, uncompacted, and continuous from the inner base layer edge through the shoulder line. The equipment must be capable of spreading this layer without damaging or disturbing the underlying and contiguous layers. Multiple passes may be permitted on wide shoulders.

There will be no density requirement for this layer. Care shall be taken to insure firm contact between drainage layer and the contiguous base layers.

Any disturbance to or loss of drainage plane material while uncovered shall be corrected prior to placing the overlying layer.

315.04 Method of Measurement.

Measurement of Drainage Plane Material will be in accordance with Article 301.07.

315.05 Basis of Payment.

(a) Unit Price Coverage.

Drainage Plane Material, measured as noted above, will be paid for at the contract unit price bid for the item of work involved in accordance with Article 301.08.

(b) Payment will be made under Item No.:

315-A Drainage Plane Material, ___ inches {mm} Thick - per square yard {square meter}

SECTION 327
PLANT MIX BITUMINOUS BASE AND PATB

327.01 Description.

The work under this Section shall consist of constructing a Plant Mix Bituminous Base layer composed of an aggregate and bituminous material hot mixed in a central plant and hot laid on a prepared surface in accordance with these specifications and in close conformity with the lines, grades, typical section, mix, and average weight per square yard shown on the plans or directed by the Engineer.

The work under this Section shall also include the construction of a Permeable Asphalt Treated Base (PATB) layer to serve as a drainage layer in the pavement structure.

327.02 Materials.

(a) Plant Mix Bituminous Base.

1. Compliance with the Requirements given in Section 410.

The material requirements for Plant Mix Bituminous Base shall conform to the requirements given in Section 410 unless noted otherwise by the requirements given in this Section.

2. Mix Design.

The type of required mix will be shown on the plans. The minimum allowable VMA shall be 13.0. The job mix shall be designed by the Marshall Method to produce a minimum of 1200 pounds {5.5 kN} stability at 50 blows, unless shown otherwise on the plans.

3. Aggregate.

Fine aggregate shall meet the requirements given in Article 802.04. Coarse aggregate shall be gravel, processed reef shell, crushed slag, crushed stone, or a combination thereof meeting the requirements given in Section 801 unless noted otherwise by the requirements given in this Section.

The coarse and fine aggregates shall be combined in a total blend that will produce an acceptable job mix within the gradation limits shown in the following table. The blend shall be made from at least two stockpiles of different gradations. At least 10% of the blend shall be taken from each of the stockpiles.

The requirements for allowing the use of RAP and RAS are given in Article 410.02.

AGGREGATE FOR PLANT MIX BITUMINOUS BASE AND PERMEABLE BASE			
SIEVE	PERCENT PASSING BY WEIGHT {MASS}		
	Plant Mix Bituminous Base		Permeable Base
(Square Mesh Type)	Mix 1	Mix 2 *	PATB
2 inch {50 mm} Sieve		100	
1.5 inch {37.5 mm} Sieve	100	82 - 97	100
1 inch {25.0 mm} Sieve	95 - 100		95 - 100
3/4 inch {19.0 mm} Sieve	80 - 95	55 - 85	
1/2 inch {12.5 mm} Sieve	64 - 84		25 - 60
3/8 inch {9.5 mm}Sieve	56 - 74	40 - 65	
No. 4 {4.75 mm} Sieve	40 - 56	30 - 52	0 - 10
No. 8 {2.36 mm} Sieve	28 - 42	22 - 42	0 - 5
No. 16 {1.18 mm} Sieve	20 - 34		
No. 30 {600 μm}Sieve	13 - 26		
No. 50 {300 μm} Sieve	8 - 20	5 - 22	
No. 100 {150 μm} Sieve	4 - 14	1 - 18	
No. 200 {75 μm} Sieve	2 - 6	0 - 8	0 - 4
* Mix 2 is intended to be used as a narrow width buildup in widening projects. All design criteria on Mix 2 is waived due to the size of the coarse aggregate. The M & T Engineer will determine the liquid asphalt binder content and gradation within the general composition of the mix.			

4. Liquid Asphalt Binder.

If the grade of liquid asphalt binder is not shown on the plans the Contractor shall use PG 67-22 liquid asphalt binder. The proportion of liquid asphalt binder to total sample by weight shall be 3.5 % to 7.0 % for Mix 1 and 3.0 % to 6.0 % for Mix 2. The exact proportion shall be fixed by the job mix formula.

Additives or modifiers shall be used to prevent stripping of liquid asphalt binder if stripping is observed during design, production or laydown. These additives or modifiers shall be furnished and used at no additional cost to the State.

(b) Permeable Asphalt Treated Base Mix (PATB).

1. Compliance with the Requirements given in Section 410.

The material requirements for PATB shall conform to the requirements given in Section 410 unless noted otherwise by the requirements given in this Section.

The laying temperature for the mixture shall be as directed by the Engineer.

2. Mix Design.

PATB shall be open graded, hot laid, central plant mixed, asphalt base material with no requirement for density, air voids, VMA, or stability. The mix shall be designed with a target liquid asphalt binder content of 2.0 to 3.0 %.

3. Aggregate.

PATB shall be made with crushed stone meeting the requirements given in Section 801 unless noted otherwise by the requirements given in this Section.

The crushed stone shall meet the gradation requirements given in the table AGGREGATE FOR PLANT MIX BITUMINOUS BASE AND PERMEABLE BASE in this Section. The blend shall be made from at least two stockpiles of different gradations. At least 10% of the blend shall be taken from each of the stockpiles.

The requirements for allowing the use of RAP and RAS are given in Article 410.02.

4. Liquid Asphalt Binder.

If the grade of liquid asphalt binder is not shown on the plans the Contractor shall use PG 67-22 liquid asphalt binder. The proportion of liquid asphalt binder to total sample by weight shall be 2.0 % to 3.0 %. During the drying process, the aggregate shall not be heated to a temperature greater than 280 °F {138 °C}.

The liquid asphalt binder and the dried aggregate shall be mixed in such a manner that the finished mixture shall not exceed 250 °F {121 °C}.

Additives or modifiers shall be used to prevent stripping of liquid asphalt binder If stripping is observed during design, production or laydown. These additives or modifiers shall be furnished and used at no additional cost to the State.

5. Geotextile Filter.

The geotextile filter shall comply with the requirements given in Section 604, Geotextiles In Permeable Asphalt Treated Base Application.

(c) Sampling and Testing Frequency.

The sampling and testing requirements for Plant Mix Bituminous Base and Permeable Asphalt Treated Base are given in Article 106.09.

327.03 Construction Requirements.

(a) Plant Mix Bituminous Base.

The construction requirements for Plant Mix Bituminous Base shall be the requirements given in Section 410 unless noted otherwise by the requirements in this Section.

The edges shall be trimmed immediately after final rolling, using an accurately aligned string or wire to a tolerance of 2 inches {50 mm} outside the theoretical edge of the layer and to a slope not flatter than 1:1.

Any edge distorted by rolling shall be promptly corrected.

(b) Permeable Asphalt Treated Base Mix (PATB).

The construction requirements for Permeable Asphalt Treated Base shall be the requirements given in Section 410 unless noted otherwise by the requirements in this Section.

A static steel wheel roller shall be used to compact the permeable base applying 0.5 to 1.0 tons per foot of roller width {1.5 to 3.0 metric tons per meter of roller width}. The roller shall make one to three passes, as directed by the Engineer, when the temperature of the mixture reaches approximately 150 °F {66 °C}.

No portion of the PATB layer shall be exposed to the elements between laydown and cover for more than five calendar days.

When required, the geotextile filter shall be furnished and installed to comply with the requirements of Section 604 or as shown on the plans or directed by the Engineer.

If rutting of PATB occurs when placing the next layer due to grade of roadway, temperature of the PATB, etc., the Engineer may require the use of a tracked paver.

No traffic shall be allowed to operate or park on the travel lane or outside shoulder portion of the permeable base. Limited operation of equipment, e.g. delivery vehicles may be permitted on the inside edge.

327.04 Method of Measurement.

Measurement of the work included under this Section will be as provided in Article 410.08.

327.05 Basis of Payment.

(a) Unit Price Coverage.

Payment for the work included under this Section will be as provided in Article 410.09.

For Pay Item 327-E, payment for furnishing and installing a required geotextile filter will not be included in this item of work. The payment for furnishing and installing a required geotextile filter will be included in Pay Item 604-A, Separative Geotextile.

(b) Payment will be made under Item No.:

327-A Plant Mix Bituminous Base, Mix ____ - per ton {metric ton}
327-B Plant Mix Bituminous Base, Patching, Mix ____ - per ton {metric ton}
327-C Plant Mix Bituminous Base, Leveling, Mix ____ - per ton {metric ton}
327-D Plant Mix Bituminous Base, Widening, Mix _____ - per ton {metric ton}
327-E Permeable Asphalt Treated Base - per ton {metric ton}

DIVISION 400
SURFACING AND PAVEMENTS

SECTION 401
BITUMINOUS SURFACE TREATMENTS

401.01 Description.

(a) General.

The work covered by this Section consists of basic bituminous treatments such as prime coat, asphalt flush coats, liquid seals, and bituminous surface treatments.

This Section also covers the work of applying a bituminous surface treatment containing a polymer additive.

Each bituminous treatment shall consist of one or more hot applications of bituminous material and, except for prime coats, includes a specified cover aggregate which shall be spread after each bituminous application.

The work also includes the cleaning of the existing surfaces as well as furnishing and applying all materials, and necessary incidental work thereto, all in accordance with plan details and these Specifications.

(b) Bituminous Treatment Table.

The following table shows the amount of bituminous material and the size and amount of cover aggregate required for the various types of bituminous treatments. The types are designated in the table by letters of the alphabet such as A, B, C, D, etc. The proposal will designate in the pay item description which of the various types are to be used. The kind of bitumen may also be specified or, if none is specified, the Contractor may select one of the kinds, if not in conflict with other provisions of these Specifications, permitted by the table. All other requirements of the tabular line opposite the type designation shall apply.

(Example: A bituminous treatment Type AKG, specifies a prime coat with the quantities specified on line "A", covered by a single surface treatment with the quantities specified on line "K", covered in turn by a seal treatment with the quantities shown on line "G".)

Bituminous materials shall be placed within the tolerance specified by the table for the type treatment involved, unless otherwise ordered by the Engineer in writing. Any variation outside of the designated limits shall be cause for ordering the treatment to be removed and replaced or corrected as directed by the Engineer, all without additional cost to the Department.

The rate of aggregate coverage shown by the table is the approximate rate found to produce an acceptable coverage when properly applied. Regardless of the rate shown, the Contractor shall provide aggregate in sufficient quantities and so spread the aggregate that the bitumen is uniformly and evenly covered.

The Engineer will notify the Contractor in writing should it become advisable to change the amounts of any material from the limits specified in the table. In such event an adjustment in the contract unit price will be made as specified in Subarticle 401.06(a).

BITUMINOUS TREATMENT TABLE SUBARTICLE 401.01(b)					
Designated Letter	Type Treatment	Aggregates ****		Gallons {Liters} of Bituminous Material per square yard {m^2} of Treatment **	
		Size	cu. ft./ sq. yd. {m^3/m^2}	Liquid Asphalt Binder	Emulsified Petroleum Resin, Cutback or Emulsified Asphalt
A	Prime Coat				0.22 – 0.25* {1.00 - 1.13}*
B	Flush Coat "B"	Sand	0.15 {0.0051}		0.16 – 0.19 {0.72 - 0.86}
C	Flush Coat "C"	9	0.20 {0.0068}		0.16 – 0.19 {0.72 - 0.86}
D	Liquid Seal "D"	78 or 89	0.25 {0.0085}	0.18 – 0.21 {0.81-0.95}	0.20 – 0.23 {0.90 - 1.04}
E	Liquid Seal "E"	78	0.25 {0.0085}	0.22 – 0.25 {1.00-1.13}	0.25 – 0.28 {1.13 - 1.27}
F	Liquid Seal "F"	78	0.27 {0.0091}	0.26 – 0.29 {1.18-1.31}	0.31 – 0.34 {1.40 - 1.54}
G	Liquid Seal "G"	7 or 78	0.27 {0.0091}	0.31 – 0.34 {1.40-1.54}	0.35 – 0.38 {1.58 - 1.72}
H	Liquid Seal "H"	6	0.40 {0.0135}	0.31 – 0.34 {1.40-1.54}	0.35 – 0.38 {1.58 - 1.72}
J	Surface Treatment "J"	6	0.42 {0.0142}	0.33 – 0.36 {1.49-1.63}	0.38 – 0.41 {1.72 - 1.86}
K	Surface Treatment "K"	5	0.50 {0.0169}	0.35 – 0.38 {1.58-1.72}	0.40 – 0.43 {1.81 - 1.95}
L ***	Surface Treatment "L"				
	1st Application	4	0.9 {0.0305}	0.35 – 0.38 {1.58-1.72}	0.40 – 0.43 {1.81 - 1.95}
	Dry Choke	78	0.20 {0.0068}		
	2nd Application	78	0.25 {0.0085}	0.55 – 0.58 {2.49-2.63}	0.62 – 0.65 {2.81 - 2.94}

* On cement treated layer, reduce prime bituminous amounts 20 percent.
** For shoulders, different amounts of aggregate and bitumen may be shown on plans or in the proposal.
*** Aggregate for this treatment shall be crushed aggregate.
**** Approximate rate of application for uniform coverage. Minor adjustments to these rates may be ordered by the Engineer to fit the physical properties of aggregates furnished for use.

Multipurpose and Cationic Emulsified Asphalts shall be in the same quantities as shown above for Emulsified Asphalt. Conversion of aggregate volume to weight {mass}, when required, shall be in accordance with AASHTO T 19.

The application rates of Bituminous Materials shown above are based on the material being at 60 °F {16 °C}.

401.02 Materials.

All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(a) Bituminous Materials, Section 804.

The grade of bituminous material shall be within the following limits unless the kind and grade are specified on the plans or in the proposal.

1. Prime:

Emulsified Asphalt	AE-P, CRS-1h, CMS-1hp, or NTSS-1HM
Cutback Asphalt	MC 3O or MC 7O for tight bases; MC 250, RC 7O or RC 250 for open bases.
Emulsified Petroleum Resin	EPR *

* This material shall not be used as a prime on processed reef shell base courses, crushed aggregate base courses, or rubblized concrete. This material shall not be left exposed for more than four days before placing a base layer of asphalt over it. This material shall also be supplied from the producer in the form in which it shall be placed. Material in a concentrated form that requires dilution after delivery will not be allowed.

2. Asphalt Flush Coat:

Emulsified Asphalt	CRS 2

3. Liquid Seals and Surface Treatments without Polymer Additive:

Liquid Asphalt Binder	PG 58-22
Cutback Asphalt	RC 250, RC 800, MC 800
Emulsified Asphalt	CRS 2, CRS 2h

4. Liquid Seals and Surface Treatments with Polymer Additive:

Liquid Asphalt Binder	PG 64-22 *
Emulsified Asphalt	CRS 2p, CRS 2hp, CRS-2l

* This liquid binder shall be manufactured from PG 58-22 with polymer additive to achieve the PG 64-22 grade.

Where the plans require the placement of a bituminous plant mix overlay over a bituminous surface treatment or liquid seal, the overlying layer shall not be placed until the asphalt in the bituminous surface treatment or liquid seal has cured to the satisfaction of the Engineer. Curing time is dependent upon several factors including temperature, humidity, and wind velocity. When emulsified asphalt is used, curing begins with a distinct change in color, from brown to black, and proceeds until the asphalt satisfactorily retains the aggregate.

Traffic stripe on each layer shall be provided and paid for in accordance with Section 701.

(b) Aggregate.

Coarse aggregates for bituminous surface treatments shall be crushed aggregate meeting the requirements of Section 801. The kind of aggregate materials used shall be at the Contractor's option within the following limits:

1. The use of carbonate stone such as limestone, dolomite, or aggregate tending to polish under traffic shall be restricted as follows, based on the average daily traffic (ADT) count in both directions:

- 500 vehicles or less per day - No restrictions apply.
- More than 500 but less than or equal to 1,000 vehicles per day - Carbonate stone shall not be used in the final application. Aggregates for the final application (wearing layer) shall be limited to siliceous aggregates such as granite, quartzite, blast furnace slag or lightweight aggregates (expanded clays or shales produced by the Rotary Kiln Method).
- Over 1,000 vehicles per day - Carbonate stone shall not be used in any application.

The above will not apply to shoulder surfacing or detours, or to bituminous surface treatments which are to be covered over with a bituminous plant mix layer.

2. Crushed gravel may be used for all applications which are to be covered with a bituminous plant mix layer, for all applications on roads having an average daily traffic count (ADT) of less than 1500 vehicles, and for all applications of shoulder surface treatment work.

(c) Polymer Additive.

The polymer additive shall meet the requirements of Section 811. The polymer additive shall be co-milled into the emulsified asphalt at the manufacturer's facility by pre-mixing the polymer into the liquid asphalt binder before the material is emulsified. This method of adding the polymer shall be at the rate of 3%, by volume, of the asphalt emulsion. Any change to the above must be approved in writing by the Engineer. The temperature of the emulsified asphalt shall be between 140 °F {60 °C} and 180 °F {85 °C} at the time of introduction of the polymer additive.

401.03 Construction Requirements.

(a) Equipment.

In general, it shall be the Contractor's responsibility to select the proper sizes and amount of equipment to provide the desired results, but the following basic items shall be provided. In addition,

all equipment necessary for the proper prosecution of the work shall be assembled on the site and must be approved and in good working order before permission to start any treatment will be given.

All equipment approved for use shall be on a trial basis, and should after a short test section the equipment prove unsatisfactory, it shall be removed, replaced, or supplemented as deemed necessary to accomplish the desired results.

1. Cleaning Equipment.

Cleaning equipment shall be capable of cleaning the surface thoroughly without cutting, tearing, or otherwise damaging the surface.

2. Pressure Distributor.

A pressure distributor shall be required and shall be so designed and operated that it will distribute the contents, at a pressure between 30 psi {200 kPa} to 75 psi {500 kPa}, in a uniform spray for the full width of the treatment area without atomization, at the rate and within the limits specified. Heating equipment shall be provided. Distributors shall be capable of circulating or agitating the bitumen throughout the heating process providing a uniform temperature, with the ranges specified herein, and suitable means shall be provided for determining such temperatures. Suitable measuring equipment for accurately measuring the volume of the contents shall be provided. The distributor shall be equipped with a spray bar of adjustable height, hand hose, and nozzle.

Heating equipment will not be required for the application of Emulsified Petroleum Resin prime.

3. Aggregate Spreader.

A self-propelled aggregate spreader with mechanically actuated spreading attachments and adjustable widths of satisfactory design and performance will be required; however, when the area to be processed is of such size or shape that to require the use of a mechanical spreader would be impractical, the Engineer may permit the aggregate to be spread manually.

4. Rollers.

A self-propelled steel wheel roller having a weight {mass} between 5 tons {4 metric tons} and 8 tons {7 metric tons} shall be required immediately behind the aggregate spreader followed by a self-propelled pneumatic tired roller. Only one coverage shall be made with the steel wheel roller.

(b) Temperature and Weather Limitations For Placement Of Surface Treatments.

All bituminous treatments shall be applied in strict conformity with the following:

1. Seasonal

No Bituminous Surface Treatment, which will be exposed to traffic, including shoulder paving, shall be placed between the dates of October 1 and May 1 in North Alabama and between the dates of November 1 and April 1 in South Alabama regardless of weather conditions. For the purpose of identification, South Alabama shall be referred to for projects lying partly or wholly in the area of the State lying south of latitude 33°N and with North Alabama encompassing the remaining or northern portion of the State. This seasonal limitation will not apply to Prime Coat.

2. Weather.

Bituminous surface treatments shall not be placed on a wet surface or when the Engineer will not allow the placement due to existing unfavorable weather conditions. They shall not be placed when the temperature is expected to fall below freezing during the night regardless of daytime temperature, when the ground is frozen, or when the surface temperature is less than 32 °F {0 °C}.

Bituminous Surface Treatment A (Prime Coat) shall not be placed when the air temperature is below 40 °F {4 °C}. All other bituminous surface treatments (B, C, D, etc.) shall not be placed when the air temperature is below 60 °F {15 °C}.

3. Moisture in Aggregate.

Aggregates spread when the temperature is 70 °F {20 °C} and above may be surface damp but not wet. Aggregates spread when the temperature is below 70 °F {20 °C} shall be surface dry. Aggregates found by the Engineer to contain excessive moisture or free water at the time of use shall be rejected.

The above limitations shall not be waived unless approved in writing by the Engineer.

(c) Preparation of Existing Surface.

Loose material, dust, dirt, caked clay, or any foreign material shall be removed. Cleaning shall be continued until the surface is clean or, in case of application on a soil or aggregate surface, all the loose dirt is removed and the surfaces of the larger size aggregate in the road surface are exposed but not dislodged. All cleaning of the area to be treated shall be completed before any bituminous material is applied.

(d) Application of Bituminous Material.

1. General.

No bituminous material or treatment shall be applied until the base or underlying surface has been approved.

2. Preparation of Bituminous Material.

Bituminous materials used for each treatment shall be heated as previously noted. The material shall be maintained within the specific temperature range during application. Any material which has not been maintained within the specified range shall be rejected. The following temperature (°F {°C}) ranges shall apply:

TYPE OF BITUMEN	PRIME	HOT APPLICATION
Liquid Asphalt Binder		275 °F – 350 °F {135 °C - 175 °C}
Cutback Asphalt		
RC-70, MC-30, MC-70, MC-250	100 °F – 150 °F {35 °C - 65 °C}	
RC-250		125 °F – 180 °F {50 °C - 80 °C}
RC-800, MC-800		170 °F – 240 °F {75 °C - 115 °C}
RC-3000, MC-3000		215 °F – 270 °F {100 °C - 130 °C}
Emulsified Petroleum Resin	Ambient Temperature	
Emulsified Asphalt	120 °F – 170 °F {50 °C - 75 °C}	120 °F – 170 °F {50 °C - 75 °C}
Emulsified Asphalt With Polymer Additive	- - - - - -	140 °F – 180 °F {60 °C - 80 °C}

It is recommended that, in general, liquid asphalt binders be used June through September and either emulsified asphalt or cutback be used the remainder of the season.

Emulsified Petroleum Resin prime will not be required to be heated and shall be applied at ambient temperature. No Emulsified Petroleum Resin prime shall be placed when the ambient temperature is below freezing.

3. Application of Bitumen.

The bitumen shall be applied uniformly over the area to be treated. Where the treatment width is 26 feet {8 m} or less, the entire width shall be treated in one application, unless otherwise directed. Where only a partial width is treated in one application, extreme care shall be used to insure a slight overlap of adjacent treatments, but not in excess of 4 inches {100 mm}.

The spray bar shall be adjusted to the proper height for exact single or double overlap of spray area without partial overlap. Uniformity of discharge shall be checked before beginning application and at other times as directed. Streaked areas and any other areas lacking uniform distribution shall immediately be made uniform. In all cases the distributor shall be stopped before the application begins to run light (just before the distributor tank is completely empty). A method of making joints shall be used that will insure that in beginning and ending the distribution of each load, a proper junction is made with the preceding and succeeding work without excessive bituminous material at the joints.

In applying bituminous materials, the Contractor shall use effective means to protect structures, walls, curbs, etc. from discoloration or spattering.

4. Special Details.

Before applying a prime coat, the surface shall be prepared as provided in Subarticle 401.03(c) above and, if necessary, it shall be sprinkled with water.

After the prime coat has been applied, the contractor shall keep all traffic off the road until, in the opinion of the Engineer, the prime coat is dry and cured. When directed, the Contractor shall, without extra compensation, spread the minimum necessary amount of approved clean, coarse sand over the bituminous prime to prevent its breaking up under traffic or to speed up curing.

No overlying surface shall be placed until the prime coat has been approved by the Engineer.

The Contractor shall, without extra compensation, maintain the prime treatment and the surface of the base intact until it is covered by an application of a surfacing material. Maintenance shall

include satisfactory repair to all holes, ravels, depressions, and areas deficient in prime so that the prime surface shall be smooth and of uniform texture before placing of an overlying surface.

(e) Spreading and Embedding Aggregate.

The size and amount of aggregate used shall be in accordance with provisions of Subarticle 401.01(b) for the type treatment required by the plans or proposal.

Spreading of aggregate shall follow application of bituminous material as closely as practicable using mechanical aggregate spreaders; inaccessible areas shall be covered as directed. Sufficient aggregate to cover each distributor load, in loaded trucks along with an adequate crew of workmen equipped with brooms standing by, shall be at the site before bituminous application begins.

Spreading of the aggregate shall begin and continue immediately behind the application of the bituminous material. However, if excessive rolling of the aggregate occurs during spreading, the Engineer may allow the chip spreader to delay slightly in order to hold aggregate rolling to a minimum.

Rolling shall begin immediately behind the spreading operation. Sufficient rollers shall be furnished to insure that the initial pass of the roller is made within five minutes of the spreading of the aggregate. Rolling shall be continuous, providing coverage of the entire area of treatment to insure thorough embedment of the aggregate.

Unless a sufficient number of rollers are in operation to complete the above requirement, the next load of bituminous material shall not be applied until the rolling of the previous application is completed.

When the Engineer determines the aggregate has been thoroughly embedded, rolling shall cease and the Contractor shall, without delay, remove all excess aggregate from the treatment area.

(f) Special Construction Requirements for placing of Bituminous Treatment "L".

When placing surface treatment "L", special emphasis will be placed on not allowing either public or construction traffic over the work while placing of the treatment; if this cannot be avoided, it shall be well controlled and kept to a minimum.

The sequence of placement of the material shall be as follows:

1st Step - Cleaning of surface and applying the first application of bitumen at the rate shown in Subarticle 401.01(b).

2nd Step - Placement of cover aggregate so as to have a uniform cover in contact with the asphalt. The surface should then be rolled with a light roller to key the aggregate with the asphalt.

3rd Step - Place dry choke aggregate and continue rolling and brooming until voids are filled.

4th Step - Apply 2nd application of hot bitumen at rate shown in Subarticle 401.01(b).

5th Step - Apply 2nd application of aggregate and continue brooming and rolling until the voids are filled and the aggregate is keyed to the asphalt.

401.04 Maintenance and Protection of Surface and Traffic.

Maintenance shall include immediate repair of any failures or defects that occur, repeated as often as is necessary to keep the surface continuously intact and acceptable. Maintenance shall be performed without direct compensation.

Unless otherwise specified on the plans or in the proposal, the Contractor shall handle traffic through the work and over the surface except while bituminous material is actually being applied and covered with aggregate. It shall be his responsibility to take whatever steps are necessary or directed to protect both the work and the traveling public.

401.05 Method of Measurement.

Measurement will be made of the number of square yards {square meters} of accepted bituminous treatment, complete in place.

The length shall be the actual length measured along the surface of the treatment. The width shall be the designated width of completed surface. Where the pay item specifies a prime coat plus an overlying treatment, the measurement will not include the additional width of the prime coat. Where the pay item specifies a prime coat only, the width will be the specified width of the prime coat.

401.06 Basis of Payment.

(a) Unit Price Coverage.

Payment for accepted bituminous surface treatment, or bituminous surface treatment with polymer additive, Pay Item No. 401-B, measured as provided above, will be paid for at the contract unit price per square yard {square meter} complete in place for the type of bituminous treatment specified in the proposal by the type designation letter or letters; except that adjustments in the

contract unit price shall be made as follows: When changes in amounts of treatment materials are ordered as provided in Article 401.01, the contract unit price will be adjusted upward or downward accordingly. Adjustment will be based on the increase or decrease in amounts per square yard {square meter}, at the verified cost, f.o.b. delivery point plus 2 cents per gallon {0.5 cent per liter} for the bitumen, and the verified cost per square yard {cubic meter} for the aggregate delivered to the spreader. The contract unit price or adjusted contract unit price for the accepted area complete in place shall be payment in full for furnishing all material, placement of materials, maintenance thereof and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

401-A Bituminous Treatment Type designation letter/letters, Type of bitumen, if specified - per square yard {square meter}

401-B Bituminous Treatment Type designation letter/letters, Type of bitumen, if specified (With Polymer Additive) – per square yard {square meter}

SECTION 402
SLURRY SEAL COAT

402.01 Description.

This Section shall cover the work of constructing a surface course approximately 1/8 to 3/8 of an inch {3 to 10 mm} in thickness placed on existing paved surfaces in accordance with these specifications and within reasonably close conformity to the lines, grades, and widths shown on the drawings and as specified.

402.02 Materials.

(a) Asphalt Emulsion.

CQS-1h or CQS-1hp shall meet the requirements of Section 804.

(b) Aggregate.

Aggregate shall meet the appropriate requirements of Section 801 and 802 with lightweight aggregate and manufactured sand made from limestone added to the list of approved stones.

(c) Filler.

Filler, if required, shall meet the requirements of Section 805.

(d) Water.

The water shall be potable and free from harmful soluble salt.

(e) Composition of Mixtures.

The aggregate, asphalt emulsion, water and, if required, filler meeting the requirements herein specified, shall conform to the composition by weight {mass} percentages as specified by the Engineer, but within the limits of Table A of this Section.

Type I. This aggregate blend is used to seal cracks and fill voids. It should be used on areas where a minimum wearing surface and a maximum seal is desired. This fine gradation requires an application rate of 4 to 10 pounds {2 to 5 kg} of dry aggregate per square yard {square meter}.

Type II. This aggregate blend is used to give crown corrections and a moderate wearing surface. This surface course shall be used in areas that require this size of aggregate to fill in voids and leave a substantial wearing surface. This gradation requires an application rate of 10 to 20 pounds {5 to 10 kg} of dry aggregate per square yard {square meter} resulting in a surface thickness of approximately 1/8 to 3/8 of an inch {3 to 10 mm}.

The slurry seal shall meet the requirements of Subarticle 410.02(b) where applicable.

TABLE A Composition by Weight {Mass} Percentages (Based on Square Opening Laboratory Sieves) Combined Aggregate Gradations		
Passing Sieve	Type I	Type II
3/8" {9.5 mm}		100
No. 4 {4.75 mm}	100	90 -100
No. 8 {2.36 mm}	95 -100	70 - 95
No. 16 {4.18 mm}	50 - 90	45 - 70
No. 50 {300 µm}	20 - 42	15 - 35
No. 200 {75 µm}	7 - 20	5 - 15
Asphalt residue, Percent by Weight {Mass}:	7.0 - 16.0	6.0 - 15.0

402.03 Construction Requirements.

(a) Weather Limitations.

The weather limitations as specified in Item 410.03(b)1 shall apply except that slurry seal shall not be placed when the air temperature is 50 °F {10 °C} or lower; nor when the temperature of the pavement on which it is to be placed is 50 °F {10 °C} or lower.

(b) Equipment Requirements.

The slurry seal mixing equipment shall be an approved self-propelled, continuous-flow apparatus consisting of a composite of all the required units herein described. The apparatus shall be capable of proportioning, combining, and mixing accurately the specified components into a homogeneous mixture with an asphalt film of sufficient thickness to furnish the desired binding properties.

This apparatus shall contain bins, tanks, and receptacles of sufficient size and volume, proportioning feeders, liquid measuring meters or devices, mechanical mixer, and distributor for placing the finished mixture. All units shall be integrated, mechanized, and synchronized to deliver the component to the mixer simultaneously and in time adjusted sequence.

(c) Mixer.

The mixer shall be of the spiraled, multi-blade type or other type as approved by the Engineer. The mixing chamber shall have a stated capacity which shall not be exceeded and it shall be mechanically equipped to regulate the mixing time up to but not to exceed four minutes. It shall be equipped to pre-wet the aggregate prior to aggregate contact with the asphalt emulsion. It shall have a gate for controlling the discharge of the mixture into the distributor spreader.

(d) Spreading Equipment.

A mechanically operated type squeegee distributor shall be integrally assembled with the slurry mixer. The strike-off shall be lined with a flexible material to prevent loss of the slurry mixture during spreading. The strike-off shall have vertical adjustment available for changing grade and crown to assure uniform spreading of the mixture. The apparatus shall be equipped with a pressure system and a fog type spray bar adequate for placing a complete fog coat of water with a maximum application of 0.05 gallons per square yard {0.25 L/m²} over the pavement surface immediately preceding the spreading of the mixture.

Hand squeegees, shovels, surface cleaning machines, and hand equipment as necessary, shall be provided to perform the work.

(e) Conditioning Of Existing Surface.

Conditioning of the existing surface shall be in accordance with Subarticle 410.03(c).

(f) Placement.

The temperature of the components of the completed mixture shall be so controlled that the application temperature of the slurry seal shall be within the range designated by the Engineer but not less than 50 °F {10 °C} nor more than 125 °F {50 °C} .

(g) Joints.

1. Transverse Joints.

Transverse joints shall be constructed by either overlapping the previously cured slurry with 10 to 15 feet {3 to 4 m} of fresh slurry or by lightly wetting the area that the spreader box will touch while the slurry is still in a completely uncured, semi-fluid condition.

2. Longitudinal Joints.

Longitudinal joints shall be constructed when the slurry is completely uncured or when it is totally cured. Should the slurry be completely cured, the cured slurry at the joint area shall be wetted by the spray bar. Should the slurry be completely uncured, the slurry shall not be wetted. A burlap drag, or other suitable device, that will cause the fresh slurry coming from the spreader box to distribute itself evenly over the joint, shall be pulled along the joint seam.

(h) Curing.

Treated areas shall be allowed to cure until such time as the Engineer or inspector-in-charge shall permit their opening to traffic. All traffic shall be diverted up to a maximum of 24 hours to permit undisturbed curing of the slurry or until such time as curing has taken place and rolling has been completed.

(i) Rolling.

Any rolling required for the slurry seal shall be done with a pneumatic roller. The roller shall be capable of exerting a contact pressure during rolling of 350 to 450 kPa. Rolling shall consist of not less than four complete coverages over the specified areas.

(j) Tack Coat.

When specified, a tack coat shall be placed in accordance with Section 405.

402.04 Method of Measurement.

The amount of slurry seal coat, applied as directed and accepted, will be measured in square yards {square meters}. The length will be the actual length measured along the surface. The width will be the actual width sealed as shown on the plans or directed.

402.05 Basis of Payment.

(a) Unit Price Coverage.

The number of square yards {square meters}, measured as provided above, will be paid for at the contract unit price for the item of Slurry Seal Coat of the type specified on the plans, complete in place, which price shall be payment in full for furnishing all materials and constructing the Slurry Seal Coat, and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

402-A Slurry Seal Coat, Type __* - per square yard {square meter}

* Indicate I or II

SECTION 403
MICRO-SURFACING SEAL COAT

403.01 Description.

This Section covers the materials, equipment, construction, and application procedures for placing Micro-Surfacing material for filling ruts and for surfacing existing paved surfaces. The Micro-Surfacing shall be a mixture of a polymer modified asphalt emulsion, 100 percent crushed mineral aggregate, mineral filler, water, and other additives for control of set time in the field. All ingredients shall be properly proportioned, mixed, and spread on the paved surface in accordance with the Specification and as directed by the Engineer.

403.02 Materials.

All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(a) Aggregate.

1. Coarse aggregates for microsurfacing seal coat shall be crushed aggregate meeting the requirements of Section 801. The kind of aggregate materials used shall be at the Contractor's option within the following limits.

2. The use of carbonate stone such as limestone, dolomite, or aggregate tending to polish under traffic shall be restricted as follows, based on the average daily traffic (ADT) count in both directions:

500 vehicles per day or less - No restrictions apply.

501 to 5,000 vehicles per day - Carbonate stone shall be limited to a maximum of 30% of the blended gradation.

Over 5,000 vehicles per day - Carbonate stone shall not be used in any application. Aggregates shall be limited to siliceous aggregates such as granite, quartzite, blast furnace slag or lightweight aggregates (expanded clays or shales produced by the Rotary Kiln Method). Crushed gravel shall have a bulk specific gravity greater than 2.550 (AASHTO T 85). The aggregate shall meet the appropriate requirements of Sections 801 and 802, and the following:

Test Property	Test Method	Specification
Sand Equivalent on material passing No. 4 Sieve	AASHTO T 176	65 Min
LA Abrasion	AASHTO T 96	36% Max
Sodium Sulfate Soundness	AASHTO T 104	10% Max

3. Aggregates shipped to the project shall be uniform and shall not require blending or pre-mixing at the storage area before use and shall meet the appropriate gradation as shown in Table No. 1 in Article 403.03. All aggregates shall be thoroughly screened directly into the support vehicles prior to the application of any mixture to eliminate the potential of oversized and deleterious materials.

(b) Mineral Filler.

The mineral filler may be any recognized brand of non-air entrained Portland cement or hydrated lime that is free of lumps, or any other mineral additive approved by the Engineer. It shall be accepted upon visual inspection. The amount of mineral filler needed shall be determined by the laboratory mix design and shall be considered as part of the material gradation requirement. The mineral filler shall not exceed 3% of the weight of the aggregate, and shall have a mixture control tolerance of ±0.25%.

(c) Asphalt Emulsion.

The emulsified asphalt shall be either a cationic type CQS-1hp meeting the requirements of Section 804 or a cationic type CSS-1h meeting the requirements of Section 804. The CSS-1h shall also be polymer modified containing a minimum of 3.0% polymer by volume. The polymer shall conform to the requirements given in Section 811.

(d) Water.

The water for the Micro-Surfacing mixture shall be potable and free from any contaminants detrimental to the mixture.

(e) Other Additives.

The emulsion manufacturer shall provide other additives as required to control the set time of the mixture in the field.

403.03 Composition of Mixture.

(a) Constituents

The Micro-Surfacing material shall be a uniform mixture of aggregate, polymer modified emulsified asphalt, mineral filler, water and other additives as required to control set time in the field. The Engineer will require immediate adjustments or replacement of any constituent as needed to produce an acceptable mixture. The constituents shall be proportioned to produce a uniform mixture meeting the requirements of Table No. 1.

TABLE NO. 1	MICRO-SURFACING DESIGN LIMITS		
GRADATION REQUIREMENTS			
Mixture Control Tolerances	Sieve Size	Percent Passing	
		Type II	Type III
± 0 %	3/8 inch	100	100
± 5 %	No. 4	90 – 100	70 – 90
± 5 %	No. 8	65 – 90	45 – 70
± 5 %	No. 16	45 – 70	28 – 50
± 5 %	No. 30	30 – 50	19 – 34
± 5 %	No. 50	18 – 30	12 – 25
± 3 %	No. 100	10 – 21	7 – 18
± 2 %	No. 200	5 – 15	5 – 15
DESIGN REQUIREMENTS			
± 0.75 %	Range for Residual Asphalt	6.0 – 10.0	5.0 – 9.0
		Specification	Test Method
	Mixing Time Test, secs @ 77° F (25° C),	120 minimum	ISSA TB 102
	Mix Time @ 50 and 100° F (10° C and 37.7° C)	(informational)	ISSA TB 102
	Set Time Tests: 30 minutes	12 kg-cm minimum	ISSA TB 139
	Early Rolling Traffic Time: 60 minutes,	20 kg-cm minimum	ISSA TB 139
	Wet Stripping Test, % coating	90% minimum	ISSA TB 114
	Wet Track Abrasion Test, loss in g/ft2 (g/m2)	75 (800) max 6 days 50 (538) max. 1 hour	ISSA TB 100
	Measurement of Excess Asphalt	Max. 50 grams/ft2 (540 grams/m2) Sand Adhesion, 1,000 Cycles @ 125lbs. (57 kgs)	ISSA TB 109
	Classification Compatibility	11 pt. minimum	ISSA TB 144

Note 1: Percent residual asphalt based on weight of dry aggregate.
Note 2: Type II for spread rates of 10 - 20* pounds per square yard based on dry aggregate weight.

Note 3: Type III for spread rates of 15 – 30* pounds per square yard based on dry aggregate weight.
Note 4: If more than 30 pounds per square yard of mixture is required, additional lifts shall be applied.
Note 5: The gradation and percent residual asphalt as shown on the Micro-Surfacing design or as established by the Engineer shall be maintained with the listed Mixture Control Tolerances.
* The Micro-surfacing type and target spread rate will be as shown in the plans and shall be controlled to within plus or minus 2 pounds per square yard except in no case shall a spread rate be less than the minimum be allowed. Scratch courses and rut filling applications are exempt from this specifications as rates will vary based upon the depth of the ruts and shall be spread as separate lifts.

(b) Mixture Design.

At least three weeks prior to beginning work, the Contractor shall submit to the Materials and Tests Engineer a mix design with certified test results along with representative samples of each ingredient to be used in the Micro-Surfacing mixture. The sample shall include information relative to sources, type of materials, and project number. The job mix formula shall be designed in accordance with the International Slurry Surfacing Association (ISSA) recommended guidelines and technical bulletins. Mixing tests shall pass at the maximum expected air temperature in accordance with ISSA T 113. If aggregate proportions are changed, a new job mix formula shall be submitted for approval. No Micro-Surfacing work shall begin nor shall any mixture be accepted unless the Bureau of Materials and Tests has evaluated the Micro-Surfacing design.

403.04 Equipment.

(a) General.

All equipment, tools, and machines used in the performance of this work shall be approved by the Engineer. No work shall be attempted with equipment that is malfunctioning. The Engineer may order that the work be discontinued if sufficient equipment and tools are not in use to place the materials satisfactorily.

(b) Mixing Equipment.

The paving mixture shall be mixed by a self-propelled Micro-Surfacing mixing machine which shall be a front feed continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, field control additives and water to a revolving multi-blade, twin shafted mixer and discharge the mixed product uniformly on a continuous flow basis.

Additionally the mixing machine shall be equipped with dual side driving stations of original equipment manufacturers design that will assist in proper alignment when applying mixture. A spray bar shall be provided to completely wet the aggregate entering the pugmill with additive (if used) and water. The Contractor shall provide a computerized material monitoring system with integrated materials control devices that are readily accessible and positioned so the amount of each material used can be determined at any time. Each material control device shall be clearly marked and calibrated prior to mix application.

The mixer shall be equipped with a back-up electronic materials counter that is capable of recording running count totals for each material being monitored. . The mixer shall have the capability to record and display the following information:

- Individual sensor counts for emulsion, aggregate, mineral filler, water and additive;
- Aggregate, emulsion, and mineral filler output in lbs. per minute;
- Ground travel distance;
- Spread reate in lbs. per square yard;
- Percentages of emulsion, mineral filler, water, and additive;
- Cumulative totals of aggregate, emulsion, mineral filler, water, and additive;
- Scale factor for all materials.

The Contractor shall calibrate the mixing machine for each material type with a minimum of 3 tests. The mixing machine shall be calibrated every time a material component is changes. Additional calibrations may be required during production as directed by the Engineer.

1. Water Pressure System.

   The mixing machine shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box when required.

2. Proportioning Devices.

   Individual volume or weight controls for proportioning each material to be added to the mix shall be provided and properly marked. These proportioning devices shall be used in materials calibration and for determination of materials output at any time. Each mixing unit shall be calibrated prior to commencement of the work.

3. Emulsion Pump.

   The emulsion pump shall be a heated, positive displacement type pump.

(c) Spreading Equipment.

The Micro-Surfacing mixture shall be spread uniformly by means of a hydraulically adjustable type spreader box with a positive screed adjustment and equipped to expand as necessary for varying pavement widths attached to the mixer, equipped with ribbon flighted augers to agitate and spread the materials throughout the box. These augers shall be designed to maintain sufficient turbulence in the mixture to prevent the material from setting-up in the box or causing buildup and lumps. A front seal shall be provided to ensure no loss of the mixture at the road contact surface. The rear seal shall act as a final strike-off and shall be adjustable. The spreader shall be maintained to prevent the loss of the paving mixture in surfacing super-elevated curves. The spreader box and rear strike-off shall be designed and operated so that a uniform consistency is achieved to produce a free flow of material to the rear strike-off without causing skips, lumps, or tears in the finished surface.

(d) Rut-Filling Equipment.

Microsurfacing materials may be used to fill ruts, utility cuts, depressions in the existing surface, and minor surface blemishes. Ruts less than 0.5 inches in depth shall be filled with a leveling course

pulled full width with the spreader box. Ruts equal to or greater than 0.5 inches in depth shall be filled independently with a rut-filling box. Ruts greater than 1.5 inches in depth may require multiple applications with the rut-filling box to restore the cross-section. The rut-filling box shall be either 5 foot or 6 foot in width. All rut-filling material shall be allowed to cure under traffic for at least 24 hours before any additional material is placed.

(e) Auxiliary Equipment.

Suitable crack and surface cleaning equipment, barricading equipment, hand tools and other support equipment shall be provided by the Contractor as necessary to perform the work.

(f) Equipment Calibration

Each mixing unit shall be calibrated in the presence of the engineer prior to the start of the project.

Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted. Additional calibrations may be required during production as directed by the Engineer.

Calibrations shall be performed in accordance with ALDOT procedure 454, "Calibration of Microsurfacing Equipment". The Contractor shall provide a copy of the of the calibration worksheets to the Engineer.

403.05 Construction.

(a) Weather Limitations.

The Micro-Surfacing mixture shall be spread only when the ambient temperature for the 48 hours prior to placement is at least 50° F. The current pavement surface and ambient temperature is at least 50° F and rising. The weather is not foggy or rainy and there is no forecast of temperatures below 32° F within 48 hours from the time of placement. The Micro-Surfacing mixture shall be spread at the discretion of the Engineer if the relative humidity exceeds 80 percent or the weather is overcast.

(b) Surface Preparation.

The area to be surfaced shall be thoroughly cleaned of vegetation, loose aggregate, and soil. All cracks shall be cleaned to the satisfaction of the Engineer prior to overlay. Traffic markings and stripe shall be removed flush with the pavement surface. Whenever conditions are such as to require pre-wetting the surface, the water shall be sprayed ahead of and outside of the spreader box at a rate sufficient to dampen the surface without any free flowing water ahead of the spreader box.

(c) Application.

The paving mixture shall be spread on the prepared surface in such a way as to leave a uniform finished surface. Care shall be taken when filling ruts to restore the designed profile of the pavement cross section. Excess crowning or overfilling of the rut area will not be permitted. The Contractor shall use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading. A sufficient amount of material shall be carried at all times in all parts of the spreader box to ensure complete coverage. No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the mix will be removed from the pavement. The paving mixture shall have proper consistency so that excessive splattering and excessive free water is avoided. The paving mixture shall be applied based on dry aggregate weight as specified on the plans.

Adjustments to the additive will be permitted if necessary to provide a slower setting time when hand spreading is needed. If hand spreading is necessary, the mixture shall be poured in a small windrow along one edge of the surface to be covered and then spread uniformly by a hand squeegee or lute. A smooth, neat seam shall be provided where two passes meet. Excess material shall immediately be removed from ends of each run.

(d) Joints

Longitudinal joints and transverse joints shall have no more than ¼ inch vertical space over the joint when measured with a 10 ft. straightedge placed perpendicular to the joint. A maximum of 3 inches shall be allowed for overlap of the longitudinal lane line joints. The edge lines shall be repaired if the edges vary more than 3 inches from a 100 foot straight line or from a 100 foot arc on a curved section.

(e) Traffic Control.

Traffic shall not be allowed on the Micro-Surfacing mixture until it has cured sufficiently to prevent pick up and/or marring of the surface. Curing of the Micro-Surfacing with the ability to carry rolling traffic shall be within 60 minutes of placement. The Contractor shall maintain traffic control as necessary to prevent damage to the mixture. Any such damage done by traffic to the mixture shall be repaired by the Contractor at no additional cost to the Department.

Application of the surfacing mixture shall be suspended early enough each day to permit traffic to safety travel over the completed work before sunset. Work required or materials used in controlling of traffic will not be paid for directly but shall be considered subsidiary obligations of the item of Micro-Surfacing seal coat.

(f) Quality Control

The Contractor shall produce a mixture in compliance with the mix design, mixture control tolerances and spread rate placement tolerances. The Contractor shall maintain all quality control documentation. Quality control documentation shall be made available to the Engineer upon request or at the completion of work.

1. Asphalt Cement
   The Contractor shall calculate the % asphalt content of the mixture from the equipment computer display readings, a minimum of 3 times a day.
2. Application Rate
   The Contractor shall calculate the yield of the course being placed from the equipment computer display readings, a minimum of 3 times a day.
3. Daily Report
   The daily report shall include aggregate used in tons, asphalt emulsion used in tons, mineral filler used in tons, water used in mixture in gallons, and additive used in mixture in gallons.

(g) Test Strip

Prior to production application, the Contractor shall place a 1,000 foot test section to verify the mix design and the ability to carry rolling traffic within 60 minutes. If rolling traffic cannot be carried within 60 minutes, the emulsion or mixture must be adjusted and another test strip shall be required. The test section shall be placed at the same time as the paving is to take place, night or day, and under the same ambient conditions.

(h) Testing and Lots.

The Engineer will take samples of the aggregate and liquid asphalt emulsion for every 1000 tons of aggregate used in production and as otherwise deemed appropriate. A BMT-91 is required for all aggregates shipped for use on the project. Aggregates will be sampled in accordance with AASHTO R 90. If tests on either component material or the mixture fails, the operation shall cease. It will be the responsibility of the Contractor to prove that the problems have been corrected and that a satisfactory operation can be accomplished before work can be started again.

A LOT is normally defined as 10,000square yards. For each LOT the Contractor shall provide a lot sheet containing the following information:

- Lot Number, Job Number, Route, Inspector;
- Date, Air Temperature;
- Control settings, calibration Values, Unit Weight of emulsion in lbs. per gallon, Percent residue in emulsion;
- Beginning and Ending Intervals
- Computer display readings for materials usage (Beginning, and Ending, and Total)
- Length, Width, Total Area in square yards of aggregate, pounds of Emulsion, and pounds of cement;
- Percent of each material, percent of asphalt cement, application rate, and combined application rate in lbs./sy.;
- Mix design percentages of materials required;
- Calibration forms;
- Contractor’s authorized signature

403.06 Method of Measurement.

The quantity of Micro-Surfacing mixture, of the type specified, used and accepted will be measured in tons. A means, suitable to the Engineer, for confirmation of the weights of the materials shall be

furnished by the Contractor. The weight of the dry aggregate, asphalt emulsion, and the cement used in the mixture shall be calculated and included in the total weight measured for payment. Additional materials such as mineral fillers, water, and chemical additives shall be included in the contract price for micro-surfacing seal coat and will not be measured separately for payment.

Deductions in measurement will be made for all material wasted or lost or applied beyond the limits of the work.

403.07 Basis of Payment.

(a) Unit Price Coverage.

Compensation for the Micro-Surfacing material, measured as provided above, will be made on a tonnage basis and the contract unit price per ton shall be full compensation for construction of the Micro-Surfacing complete in place as shown on the plans or directed. This price shall include all materials, procurement, handling, hauling, and processing and includes all equipment, tools, labor, and incidentals required to complete the work, with the following exception:

Tonnage placed in excess of the amount shown on the plans or directed in writing, plus two pounds per square yard, will be paid for at eighty percent of the contract unit price bid.

No payment will be made for unacceptable material; for material furnished or used in excess of the amount indicated or directed, except as provided above; for material used in replacing defective or condemned work; for material wasted in handling, hauling, or otherwise; or for maintaining the work.

(b) Payment will be made under Item No.:

403-B Micro-Surfacing Seal Coat, Type _*_- per ton

* Specify Type “II” or “III”.

SECTION 405
TACK COAT

405.01 Description.

The work under this Section shall cover the furnishing and placing of a bituminous tack coat on a surface which is to be covered by a bituminous plant mix material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or directed by the Engineer.

The work shall include cleaning the surface prior to application of the tack coat.

The area of treatment and the rate of application of a tack coat shall be based on the plans and specifications after evaluating the actual surface condition on which the plant mix overlay is to be placed.

405.02 Materials.

(a) Tack Coat

Bituminous material for tack coat shall be Emulsified Asphalt or one of the Performance Graded (PG) Asphalt Binders shown in Article 804.07. Emulsified Asphalts shall not be diluted prior to application. The Contractor shall have the option of using the following materials for the tack coat:

- PG 58-22 performance graded asphalt binder
- PG 64-22 performance graded asphalt binder
- PG 67-22 performance graded asphalt binder
- PG 76-22 performance graded asphalt binder
- CRS-1H emulsified asphalt
- CRS-2 emulsified asphalt
- CRS-2H emulsified asphalt
- CMS-1HP emulsified asphalt
- CSS-1 emulsified asphalt
- CSS-1H emulsified asphalt
- CQS-1H emulsified asphalt
- CQS-1HP emulsified asphalt
- CRS-2P emulsified asphalt
- CRS-2L emulsified asphalt

- CBC-1HT emulsified asphalt
- CNTT-1HS emulsified asphalt
- BC-1HT emulsified asphalt (anionic)
- NTSS-1HM emulsified asphalt (anionic)
- NTQS-1HL emulsified asphalt (non-ionic)

In lieu of tack coat, materials listed in Subarticle 405.02(b) may be applied to adjacent pavement edges and joints as described in Item 2 of Subarticle 405.03(d).

Unless shown otherwise on the plans, the contractor shall have the option of using any of the allowable bituminous materials, subject to other limitations of these specifications. In making the selection of materials, the Contractor shall take into consideration seasonal, weather, temperature, and other placement conditions, while keeping in mind that SS stands for slow setting, RS stands for rapid setting, and QS stands for quick setting (QS is the faster setting or breaking emulsion). Low temperatures and humid or damp conditions will retard the breaking or setting of all emulsions. The mixing of a cationic and an anionic emulsion will result in failure of emulsion materials. All materials shall meet the requirements of Section 804.

CQS-1HP shall be a cationic emulsion blended with a minimum of 1.2% polymer meeting the requirements given in Article 811.03 and the requirements given in the following table:

CQS-1HP MODIFIED ASPHALT EMULSION			
TEST OF EMULSION			
Parameter	Test Method	Value	
Residue % By Distillation	ALDOT 415	60 % Min.	-
Viscosity, SF @ 77 °F, sec.	AASHTO T 59	20 SF Min.	100 SF Max.
Sieve Test, %	AASHTO T 59	-	0.1 % Max.
Particle Charge	AASHTO T 59	Positive	
TEST OF RESIDUE FROM EMULSION			
Parameter	Test Method	Value	
Penetration, 100 g, 5 secs. @ 77 °F	AASHTO T 49	60 mm Min.	130 mm Max.
Ductility, cms., @ 39.2 °F	AASHTO T-51	40 cms Min.	-
Elastic Recovery @ 50 °F, %	AASHTO T-301	50 % Min.	-

(b) Additional Materials for Application on Adjacent Pavement Edges and Joints.

The Contractor may use the following materials in lieu of tack coat for application on adjacent pavement edges and joints.

- Pavon™;
- Crafco™ Pavement Joint Adhesive Part No. 34524.

Pavon™ is a proprietary product that shall also meet the requirements given in the following tables.

REQUIRED PROPERTIES FROM THE TESTING OF Pavon™			
Parameter	Test Method	Value	
Residue % By Distillation	ALDOT 415	60 % Min.	-
Viscosity, SF @ 77 °F, sec.	AASHTO T 59	20 SF Min.	100 SF Max.
Sieve Test, %	AASHTO T 59	-	0.1 % Max.
Particle Charge	AASHTO T 59	Positive	

REQUIRED PROPERTIES FROM THE TESTING OF DISTILLATION RESIDUE FROM Pavon™			
Parameter	Test Method	Value	
Penetration, 100 g, 5 secs. @ 77 °F	AASHTO T 49	60 mm Min.	130 mm Max.
Ductility, cms., @ 39.2 °F	AASHTO T-51	40 cms Min.	-
Elastic Recovery @ 50 °F, %	AASHTO T-301	50 % Min.	-

Crafco™ Pavement Joint Adhesive Part No. 34524 is a proprietary product that shall meet the requirements given in the following table:

REQUIRED PROPERTIES FROM THE TESTING OF Crafco™ PAVEMENT JOINT ADHESIVE PART NO. 34524		
Parameter	Test Method	Value
Cone Penetration, 77 ºF	ASTM D5329	60-100
Flow, 140 ºF	ASTM D5329	5 mm-Maximum
Resilience, 77 ºF	ASTM D5329	30 %-Minimum
Ductility, 77 ºF	AASHTO T51	30 cm-Minimum
Ductility, 39.2 ºF	AASHTO T51	30 cm-Minimum
Softening Point	AASHTO T53	170 ºF Minimum

405.03 Construction Requirements.

(a) Equipment.

In general it shall be the Contractor's responsibility to select the proper size and amount of equipment to provide the desired results. Equipment furnished shall meet the requirements of Subarticle 401.03(a).

(b) Seasonal, Nighttime, Weather, and Temperature Limitations.

1. Seasonal Limitations for the Placement of Tack.

Grades CSS-1 and CSS-1h Emulsified Asphalts shall not be placed between the dates of October 1 and May 1 in North Alabama and between the dates of November 1 and April 1 in South Alabama regardless of weather conditions. For the purpose of identification, South Alabama shall be referred to for projects lying partly or wholly in the area of the State lying south of latitude 33 °N, with North Alabama encompassing the remaining portion of the State. These seasonal limitations shall not apply to the placement of other bituminous materials for tack allowed by Article 405.02. The tack may be placed if allowed by the Engineer when the pavement temperature is 40°F and rising.

2. Nighttime Limitations for the Placement of Tack.

Grade CSS-1 and CSS-1h Emulsified Asphalts shall not be used for tack during nighttime paving operations.

3. Weather Limitations for the Placement of Tack.

Tack material shall not be applied on a wet surface or when in the Engineer's opinion weather conditions are not suitable. NTSS-1HM may become slippery when wet.

4. Temperature Limitations for the Placement of Tack.

Temperature limitations for the placement of tack coat material shall be the same as specified in Subarticle 410.03(b) for plant mixed pavements. NTSS-1HM material shall not be used for cold applied asphalt pavement.

(c) Preparation of Surface.

Loose material, dust, dirt, and all foreign matter shall be removed from the surface to be treated. All existing surfaces (new pavement, milled pavement, old pavement, or concrete) shall be clean and dry prior to the tack coat application. Cleaning operations can be achieved either through mechanical brooming, by flushing with water, vacuuming, blowing off debris using high-pressure air or other methods as determined by the contactor, unless otherwise shown on the plans. The existing surface shall be approved by the Engineer before application of the tack material.

(d) Application.

1. General.

Tack coat material application rates and temperatures shall meet the requirements given in the tables below:

UNDILUTED APPLICATION RATE BY SURFACE TYPE, gal/yd^2				
Tack Material	New HMA or New Surface Treatment	Existing HMA or Existing Surface Treatment	Milled Surface	PCC
Emulsions	0.03 - 0.07	0.06 - 0.11	0.06 – 0.12	0.05 – 0.08
PG Asphalt Binder	0.02 – 0.05	0.04 - 0.07	0.04 – 0.09	0.03 – 0.05

TACK APPLICATION TEMPERATURES, °F	
Cationic Emulsified Asphalt	130 – 170
Anionic Emulsified Asphalt	150 – 180
Non-Ionic Emulsified Asphalt	150 – 180
PG Asphalt Binder	275 - 375

Tack coat shall be applied uniformly to the pavement surface to obtain full coverage. Tack coat applications that are streaky or striped in appearance will not be allowed and shall be reapplied.

An asphalt distributor shall be provided for use on all accessible areas; inaccessible areas such as around manholes, etc. may be coated by other methods, approved by the Engineer.

Tack coat shall be applied to all contact surfaces of curbs, gutters and manholes. Tack shall also be applied to the adjacent pavement edges (transverse and longitudinal) of all new base layers of Section 424 (Superpave), binder and wearing layers of Section 424 (Superpave) and Section 423 (Stone Matrix Asphalt), and to the joints in the surface layers between existing HMA pavement and new HMA pavement. This tack may be applied with the pavement surface tacking operation or in a separate pass. In either case, the surfaces, edges, and joints shall be thoroughly coated with tack.

Adjacent surfaces, such as gutters and the like, that are not to be in contact with the mix shall be adequately protected from the spray by means of heavy paper securely fastened in place or by other satisfactory means. Any such surface soiled by tack coat material shall be cleaned and restored to its previous condition without additional compensation.

2. Crafco™ and Pavon™.

The following will apply if the Contractor uses Crafco™ or Pavon™ for application on adjacent pavement edges and joints.

As a separate application from the tack coat, these products shall be applied by being sprayed or rolled on the face of the adjacent pavement edges and joints.

These products shall be placed at the rates and temperatures given in the following table.

APPLICATION RATES AND TEMPERATURES		
Product	**Application Rate**	**Application Temperature**
Pavon™	40 gallons per mile per inch of lift with a +/-10 % tolerance	Ambient Temperature
Crafco™ Pavement Joint Adhesive Part No. 34524	70 gallons per mile per inch of lift with a +/- 10 % tolerance	360 ºF – 400 ºF

The Engineer will limit the length of product placement ahead of the asphalt spreader (usually no more than 1000 feet) to reduce the possibility of damage. The Engineer will also require the placement of Pavon™ far enough ahead of the asphalt spreader to allow the curing of the product.

(e) Curing

Tack coat materials shall be fully cured before application of the overlying asphalt pavement layer is placed. Emulsified asphalt materials are considered as cured when the emulsion color has completely turned black. The NTSS-1HM asphalt emulsion shall be covered as soon as practical.

Tack coat material shall be spread only far enough in advance to permit the construction to progress consistently, uniformly, and continuously after the curing period and shall not be applied so far in advance that the viscous quality will be reduced by traffic prior to construction thereon. Tack coat that loses its viscous quality before being covered shall be renewed and any which has been damaged shall be replaced without extra compensation.

405.04 Method of Measurement.

The amount of bituminous material used as directed for tack coat will be measured in gallons {liters}, as specified in Article 109.02. If Crafco or Pavon products are used, the Contractor shall provide a suitable means of measurement of the gallons of product used.

405.05 Basis of Payment.

(a) Unit Price Coverage.

The amount of bituminous material used as directed for tack coat, measured as noted above, will be paid for at the contract unit price bid per gallon {liter} which shall be full compensation for furnishing the bituminous material, hauling, heating, application, curing, and maintaining and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

405-A Tack Coat - per gallon {liter}

SECTION 408
PLANING (MILLING) OF EXISTING PAVEMENT

408.01 Description.

This Section shall cover the work of removing existing asphalt pavement by either planing or micro-milling. Micro-milling is required to provide a more uniform surface than can be achieved by planing.

408.02 Equipment.

The planing and micro-milling machines shall be:

- Self-propelled;
- Of a size and shape that allows traffic to pass safely through areas adjacent to the work;
- Equipped with automatic grade and cross slope controls;
- Equipped with a means to prevent dust from escaping the milling operation;
- Capable of maintaining the required depth of cut and cross slope;
- Furnished with a lighting system for night work if night work is required or allowed by the engineer;
- Provided with conveyors capable of removing the milled material and emptying it directly into trucks to be hauled away from the roadway.

Micro-milling equipment shall be capable of removing pavement to an accuracy of 1/16 of an inch.

408.03 Construction Requirements.

(a) Pavement Removal.

The existing pavement shall be removed to varying depths in a manner which will restore the pavement surface to a uniform longitudinal profile and cross section as shown on the plans or as directed by the Engineer.

The approximate depths of required removal are shown on the plans. The depth of removal shall be increased or decreased across the width of the pavement to obtain the required roadway cross slope. The Contractor may make multiple cuts to achieve the required depth of cut.

The pavement removal shall be done to effectively minimize the amount of airborne dust. Wetting of the pavement may be required to minimize the airborne dust.

The Contractor shall provide a means of drainage to prevent water accumulation on the surface where the pavement has been removed.

Unless otherwise noted on the plans, the pavement removal shall be limited to an area that will be covered with a surface treatment or a layer of pavement within the time shown below:

- For planing, within seven calendar days after removal has begun.
- For micro-milling, within 30 calendar days after removal has begun.

The Contractor shall collect, transport and dispose the removed pavement material. The removed material shall become the property of the Contractor unless otherwise noted on the plans.

After pavement removal and immediately prior to resurfacing or opening to traffic, the surface shall be thoroughly swept with a power broom to remove fine material and dust particles. Sweeping shall be conducted in a manner that will minimize the potential for creation of a traffic hazard and minimize the creation of airborne dust. Material removed by sweeping shall be collected, transported and disposed by the Contractor.

(b) Final Planed Surface.

The final planed surface shall be a uniform finish on the grade and slope shown to be required on the plans. The finished surface shall also not vary more than 1/4 of an inch from a 10 foot straightedge placed anywhere on the surface of the milled area.

The Contractor shall make adjustments to the planing equipment if these surface tolerances are exceeded.

(c) Test Section for Micro-Milling.

Micro-milling shall be performed on a test section prior to beginning the micro-milling work. The size of the test section shall be the width of the micro-milling machine and a length of 1000 feet {300 m}. The difference between the ridge and valley of the milled surface shall not exceed 1/16 of an inch when measured anywhere on the surface of the milled area.

Production micro-milling shall not begin until the Engineer approves the results of the micro-milling of a test section.

The Contractor shall make adjustments to the micro-milling equipment and micro-mill another 1000 foot {300 m} long test section for evaluation by the Engineer until an acceptable test section has been produced. The Contractor will not be allowed to start production micro-milling until an acceptable test section has been produced. Repeated test sections shall be located in areas that have not been milled.

If the surface of the micro-milling is determined to be unacceptable at any time after production begins, the Engineer will require the Contractor make adjustments to the equipment and produce another test section for evaluation and approval.

Payment will not be made for micro-milling test sections that are unacceptable. Payment will be made after adjustments have been made and the surface of the test section is milled to an acceptable finish.

(d) Final Micro-Milled Surface.

The final micro-milled surface shall be a uniform finish on the grade and slope shown to be required on the plans. The finished surface shall also not vary more than 1/4 of an inch from a 10 foot straightedge placed anywhere on the surface of the milled area. The difference between the ridge and valley of the milled surface shall not exceed 1/16 of an inch.

The Contractor shall make adjustments to the micro-milling equipment and construct a test section for evaluation and approval if these surface tolerances are exceeded.

408.04 Method of Measurement.

The planing of pavement will be measured in square yards {square meters} computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m} on the planed pavement.

The micro-milling of pavement will be measured in square yards computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m} on the micro-milled pavement.

In areas where a non-uniform layer of thickness is removed, the approximate layer thickness will be computed by averaging the depth of cut at opposite lane edges for each travelway at longitudinal measurement intervals of approximately 300 feet {100 m} or as directed by the Engineer. This average depth will be used to establish the item number under which payment will be made.

408.05 Basis of Payment.

(a) Unit Price Coverage.

The planing and micro-milling of pavement will be paid for at the contract unit price which shall be full compensation for removing the pavement, collecting, transporting and disposing of the removed pavement and other debris, the removal and disposal of pavement markers, sweeping the pavement and collecting, transporting and disposing of the swept debris and for all materials, equipment, tools, labor, and incidentals necessary to complete the work..

(b) Payment will be made under Item No.:

408-A Planing Existing Pavement (Approximately __*__ inches {mm} thru __**__ inches {mm} thick) - per square yard {square meter}

408-B Micro-Milling Existing Pavement (Approximately __*__ inches thru __**__ inches thick) - per square yard

* Lower limit of approximate thickness to be removed.

** Upper limit of approximate thickness to be removed.

SECTION 409
TRIPLE LAYER BITUMINOUS SURFACE TREATMENT

409.01 Description.

This Section covers the materials, equipment, construction, and application procedures for placing three applications of bituminous materials and aggregate for surfacing previously prepared bases or existing paved surfaces.

Bituminous materials shall be placed within the tolerance specified, unless otherwise ordered by the Engineer in writing. Any variation outside of the designated limits shall be cause for ordering the treatment to be removed and replaced or corrected as directed by the Engineer, all without additional cost to the Department.

The rate of aggregate coverage shown by the table is the approximate rate found to produce an acceptable coverage when properly applied. Regardless of the rate shown, the Contractor shall provide aggregate in sufficient quantities and so spread the aggregate that the bitumen is uniformly and evenly covered.

The Engineer will notify the Contractor in writing should it become advisable to change the amounts of any material from the limits specified in the table. In such event an adjustment in the contract unit price will be made as specified in Subarticle 409.06(a).

409.02 Materials.

All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(a) Bituminous Materials.

Sources for bituminous materials surface treatments shall meet the requirements given in Article 804.01.

The Contractor shall have the option of the following material for the triple layer surface treatment:

- CRS-2p
- CRS-2hp
- CRS-2l

CRS-2p, CRS-2hp, and CRS-2l shall meet the specific requirements given in Article 804.04 and Subarticle 804.07(e).

(b) Aggregate.

Coarse aggregates for bituminous surface treatments shall be crushed aggregate meeting the requirements of Section 801 and Section 802. The kind of aggregate materials used shall be at the Contractor's option within the following limits:

1. The use of carbonate stone such as limestone, dolomite, or aggregate tending to polish under traffic shall be restricted as follows, based on the average daily traffic (ADT) count in both directions:

$\leq$ 500 vehicles per day - No restrictions apply.

> 500 but ≤ 1,000 vehicles per day - Carbonate stone shall not be used in the final application. Aggregates for the final application (wearing layer) shall be limited to siliceous aggregates such as granite, quartzite, blast furnace slag or lightweight aggregates (expanded clays or shales produced by the Rotary Kiln Method).

> 1,000 vehicles per day - Carbonate stone shall not be used in any application.

The above will not apply to shoulder surfacing or detours, or to bituminous surface treatments which are to be covered over with a bituminous plant mix layer.

2. Crushed gravel may be used for all applications which are to be covered with a bituminous plant mix layer, for all applications on roads having an average daily traffic count (ADT) of less than 1500 vehicles, and for all applications of shoulder surface treatment work.

3. Layer 3 shall be a washed manufactured sand meeting the following gradation:

Aggregate Size Number	Description	Percent Passing By Weight, Sieve Size						
		3/8 inch	No. 4	No.8	No. 16	No. 50	No. 100	No. 200
W-10	Manufactured Sand	100	95-100	-	45-95	8-30	1-10	0-4

409.03 Construction Requirements.

(a) Equipment.

In general, it shall be the Contractor's responsibility to select the proper sizes and amount of equipment to provide the desired results, but as a minimum the following basic items given below shall be provided. In addition, all equipment necessary for the proper execution of the work shall be assembled on the site and must be approved and in good working order before permission to start any treatment will be given.

All equipment approved for use shall be on a trial basis, and if after a short test section the equipment proves to be unsatisfactory, it shall be removed, replaced, or supplemented as necessary to accomplish the desired results.

1. Cleaning Equipment.

Cleaning equipment shall be capable of cleaning the surface thoroughly without cutting, tearing, or otherwise damaging the surface.

2. Pressure Distributor.

A pressure distributor shall be required and shall be so designed and operated that it will distribute the contents, at a pressure between 30 psi {200 kPa} to 75 psi {500 kPa}, in a uniform spray for the full width of the treatment area without atomization, at the rate and within the limits specified. Distributors shall be equipped with a tachometer to indicate the application rate. Heating equipment shall be provided. Distributors shall be capable of circulating or agitating the bitumen throughout the heating process providing a uniform temperature, within the ranges specified herein, and suitable means shall be provided for determining such temperatures. Suitable measuring equipment for accurately measuring the volume in gallons of the bituminous materials before and after application shall be provided. The distributor shall be equipped with a spray bar of adjustable height, hand hose, and nozzle.

3. Aggregate Spreader.

A self-propelled aggregate spreader with mechanically actuated spreading attachments and adjustable widths of satisfactory design and performance will be required; however, when the area to be processed is of such size or shapes that to require the use of a mechanical spreader would be impractical, the Engineer may permit the aggregate to be spread manually.

4. Rollers.

A self-propelled steel wheel roller having a weight {mass} between 3 tons {3 metric tons} and 8 tons {7 metric tons} shall be required immediately behind the aggregate spreader followed by a self-propelled pneumatic tired roller. The Contractor shall ensure that the roller weights within these limits can properly seat the aggregate without fracturing the aggregate. Only one coverage shall be made with the steel wheel roller.

A self-propelled, two axles, pneumatic-tired rollers with smooth-tread rubber tires aligned such that gaps between the tires on one axle are covered by the tires of the other axle shall be required. The Contractor shall ensure that all tires are of the same size and ply rating and inflated to a minimum

of 60 psi {415 kPa}. The Contractor shall maintain tire pressure such that the difference in pressure between any two tires does not exceed 5 psi {35 kPa}.

(b) Temperature and Weather Limitations for Placement of Surface Treatments.

All bituminous treatments shall be applied in strict conformity with the following:

1. Seasonal.

No Bituminous Surface Treatment, which will be exposed to traffic, including shoulder paving, shall be placed between the dates of October 1 and May 1 in North Alabama and between the dates of November 1 and April 1 in South Alabama regardless of weather conditions. For the purpose of identification, South Alabama shall be referred to for projects lying partly or wholly in the area of the State lying south of latitude 33°N and with North Alabama encompassing the remaining or northern portion of the State.

2. Weather.

Bituminous surface treatments shall not be placed on a wet surface or when the Engineer will not allow the placement due to existing unfavorable weather conditions. They shall not be placed when the temperature is expected to fall below freezing during the night regardless of daytime temperature, when the ground is frozen, or when the surface temperature is less than 32°F {0°C}.

Triple Layer Bituminous Surface Treatment shall not be placed when the air temperature is below 60 °F {15°C}. The above limitations shall not be waived unless approved in writing by the Engineer.

All three layers of the bituminous surface treatment shall be placed prior to allowing traffic on the new surface when the air temperature is equal to or greater than 95°F {35°C} and the relative humidity is 85% or greater

3. Moisture in Aggregate.

Aggregates spread when the temperature is 70 °F {20°C} and above may be surface damp but not wet. Aggregates spread when the temperature is below 70 °F {20°C} shall be surface dry. Aggregates found by the Engineer to contain excessive moisture or free water at the time of use shall be rejected.

The above limitations shall not be waived unless approved in writing by the Engineer.

(c) Preparation of Existing Surface.

Loose material, dust, dirt, caked clay, or any foreign material shall be removed. Cleaning shall be continued until the surface is clean or, in case of application on a soil or aggregate surface, all the loose dirt is removed and the surfaces of the larger size aggregate in the road surface are exposed but not dislodged. All cleaning of the area to be treated shall be completed before any bituminous material is applied.

(d) Application of Bituminous Material.

1. General.

No bituminous material or treatment shall be applied until the base or underlying surface has been approved.

2. Preparation of Bituminous Material.

Bituminous materials used for each treatment shall be heated as previously noted. The material shall be maintained within the specific temperature range during application. Any material which has not been maintained within the specified range shall be rejected. The application temperature (°F {°C}) range for the Emulsified Asphalt with polymer additive shall be 140 °F – 180 °F {60°C - 80°C}.

The bitumen shall be applied uniformly over the area to be treated. Where the treatment width is 26 feet {8 m} or less, the entire width shall be treated in one application, unless otherwise directed. Where only a partial width is treated in one application, extreme care shall be used to insure a slight overlap of adjacent treatments, but not in excess of 4 inches {100 mm}.

The spray bar shall be adjusted to the proper height for exact single or double overlap of spray area without partial overlap. Uniformity of discharge shall be checked before beginning application and at other times as directed by the Engineer. Streaked areas and any other areas lacking uniform distribution shall immediately be made uniform. In all cases the distributor shall be stopped before the application begins to run light (just before the distributor tank is completely empty). A method of making joints shall be used that will insure that in beginning and ending the distribution of each load, a proper junction is made with the preceding and succeeding work without excessive bituminous material at the joints.

In applying bituminous materials, the Contractor shall use effective means to protect structures, walls, curbs, etc. from discoloration or spattering.

3. Application of Bituminous Materials.

Rates of application for each layer shall be as follows:

Layer	Gallons {Liters} of Bituminous Material per square yard {m^2} of Treatment CRS-2p CRS-2hp CRS-2l
1	0.23 – 0.32 {1.04 – 1.45}
2	0.20 – 0.26 {0.91 – 1.18}
3	0.20 -0.26 {0.91 – 1.18}

(e) Spreading and Embedding Aggregate.

The aggregate stone size and application rate of aggregates used shall be as follows:

Layer	ALDOT Stone Size	Application Rate cu.ft./sq.yd. {m^3/m^2}
1	7	0.18 - 0.26 {0.006 – 0.009}
2	89	0.16 – 0.22 {0.005 - 0.007}
3	W 10	0.10 – 0.14 {0.003 – 0.005}

Spreading of aggregate shall follow application of bituminous material as closely as practicable using mechanical aggregate spreaders; inaccessible areas shall be covered as directed. Sufficient aggregate to cover each distributor load, in loaded trucks along with an adequate crew of workmen equipped with brooms standing by, shall be at the site before bituminous application begins.

Spreading of the aggregate shall begin and continue immediately behind the application of the bituminous material.

Rolling shall begin immediately behind the spreading operation. Sufficient rollers shall be furnished to insure that the initial pass of the roller is made immediately behind the spreading of the aggregate. Rolling shall be continuous, providing coverage of the entire area of treatment a minimum of three (3) passes for each layer of aggregate to insure thorough embedment of the aggregate.

Unless a sufficient number of rollers are in operation to complete the above requirement, the next load of bituminous material shall not be applied until the rolling of the previous application is completed.

When the Engineer determines the aggregate has been thoroughly embedded, rolling shall cease and the Contractor shall, without delay, remove all excess aggregate from the treatment area.

The Contractor shall stage his day's work such that all three layers are placed at the end of each day's work.

409.04 Maintenance and Protection of Surface and Traffic.

Maintenance shall include immediate repair of any failures or defects that occur, repeated as often as is necessary to keep the surface continuously intact and acceptable. Maintenance shall be performed without direct compensation.

Unless otherwise specified on the plans or in the proposal, the Contractor shall handle traffic through the work and over the surface except while bituminous material is actually being applied and covered with aggregate. It shall be his responsibility to take whatever steps are necessary or directed to protect both the work and the traveling public. Both the first application layer and the second application layer shall be completed before opening the road to traffic. Traffic control shall be established such that traffic is not allowed to sit on the newly applied bituminous surface treatment.

409.05 Method of Measurement.

Measurement will be made of the number of square yards {square meters} of accepted triple layer bituminous treatment, complete in place.

The length shall be the actual length measured along the surface of the treatment. The width shall be the designated width of completed surface. Where the pay item specifies a prime coat plus an overlying treatment, the measurement will not include the additional width of the prime coat.

409.06 Basis of Payment.

(a) Unit Price Coverage.

Payment for accepted triple layer bituminous surface treatment, Pay Item No. 409-A Triple Layer Bituminous Treatment, measured as provided above, will be paid for at the contract unit price per square yard {square meter} complete in place; except that adjustments in the contract unit price shall be made as follows: When changes in amounts of treatment materials are ordered as provided in Article 409.01, the contract unit price will be adjusted upward or downward accordingly. Adjustment will be based on the increase or decrease in amounts per square yard {square meter}, at the verified cost, f.o.b. delivery point plus 2 cents per gallon {0.5 cent per liter} for the bitumen, and the verified cost per square yard {cubic meter} for the aggregate delivered to the spreader. The contract unit price or adjusted contract unit price for the accepted area complete in place shall be payment in full for furnishing all material, placement of materials, maintenance thereof and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

409-A Triple Layer Bituminous Treatment, - per square yard {square meter}

SECTION 410
ASPHALT PAVEMENTS

410.01 Description.

The work under this Section covers the general requirements that are applicable to all types of hot and warm mix asphalt pavements of the plant mix type. Deviations from these general requirements will be indicated in the specific requirements for various types of mixes noted in the following sections of these Specifications.

This work shall consist of one or more courses of hot and warm mix asphalt plant mix constructed in accordance with these specifications and the specific requirements of the type of mixture required and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. The Contractor may use either hot mix or warm mix for all Superpave ESAL Range mixes in Section 424. Warm mix asphalt shall be defined as the use of an approved warm mix technology in the plant mix at the time of production.

This work shall also include the preparation of the underlying surface on which the plant mix is to be placed, including patching and/or leveling as shown on the plans or directed by the Engineer.

In addition, this work shall also include the placing of widening at locations shown on the plans and/or directed by the Engineer. In general, widening shall consist of (1) narrow width build-ups, three feet or less {one meter or less}, required for widening existing pavement, (2) paving for turn-outs beyond three feet {one meter} from the edge of pavement, (3) pavement crossovers, and (4) turning lanes of less than 200 feet {60 m} for crossovers. Paving used on turn-outs for intersecting paved roads and shoulder paving will not be considered as widening unless shown on the plans.

Surface layers and wearing layers are defined as those layers where the pay item contains the wording “Wearing Surface”.

All ALDOT procedures referenced are applicable to both hot and warm mix asphalt.

410.02 Materials.

(a) Applicable Sections of Specifications.

Materials shall conform to requirements given in Sections 327, 420, 423 and 424.

(b) Products and Processes for the production of Warm Mix Asphalt.

Warm Mix Asphalt products and processes shall be selected from List II-27, “Warm Mix Asphalt Products and Processes” of the Department's manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

(c) Anti-Stripping Agents.

All warm mix asphalt mixtures, 327E mixes, and 420 mixes shall include an anti-stripping agent. The warm mix additive supplier may certify that an anti-stripping agent is an integral part of the warm mix additive.

All hot mix asphalt mixtures except 327E and 420 shall be tested during design to determine if an anti-stripping agent is needed. During design and production, all other mixes shall have a tensile strength ratio (TSR) of at least 0.80 when tested in accordance with AASHTO T 283 as modified by ALDOT-361. If any TSR value falls below the minimum specified above, plant operations shall cease until corrective measures are taken. However, if any visual stripping occurs in the design or field production, an anti-stripping agent shall be required if deemed necessary by the Engineer. Should it become necessary for the Contractor to include an anti-strip agent in the mix due to the occurrence of visual stripping during field production of the mix after the design tests indicated that the same mix met the above listed TSR requirement, such work will be paid for as Extra Work as defined by Article 104.03. Additional payment for the anti-strip agent will not be made in cases where the same mix has been previously used in field production and visual stripping occurred.

1. Amines.

For amine based materials, the amount of anti-stripping agent, when required, shall be 0.25 to 1.0 % by weight {mass} of the liquid asphalt binder content for liquid agents and 0.5 to 2.0 % by weight {mass} of the total aggregate for powdered agents. Liquid anti-stripping agent shall be added to the liquid asphalt binder within ±10% of the specified rate, either at the refinery or the Contractor's mixing plant, using approved on-line blending equipment.

2. Hydrated Lime.

For hydrated lime materials the amount of anti-stripping agent, when required, shall be 0.5 to 2.0 % by weight {mass} of the total aggregate for powdered agents. Hydrated lime materials shall meet the requirements as given in Section 805.

3. OrganoSilanes.

For organosilane based materials the amount of anti-stripping agent, when required, shall be 0.05 to 0.1 % by weight {mass} of the liquid asphalt binder content for liquid agents. Liquid anti-stripping agent shall be added to the liquid asphalt binder by approved on-line blending equipment either at the refinery or the Contractor's mixing plant within ±10% of the specified rate.

4. Silicone

Silicone may be used in liquid asphalt binder, not to exceed 2 ounces per 5000 gallons {3 ml per 1000 L}. Except when producing Warm Mix Asphalt, other additives shall not be added to the liquid asphalt binder unless expressly authorized in writing by the Materials and Tests Engineer.

The use of any unauthorized additive will be cause for rejection of the mixture.

5. Warm Mix Asphalt Additives

Approved Warm Mix Asphalt Additives from ALDOT list II-27 May be used in liquid Asphalt Binder as an anti-striping agent when used as directed by the Manufacturer.

The use of any unauthorized additive will be cause for rejection of the mixture.

(d) Composition of Mixtures.

1. Adjustments to Rate of Placement.

The project designated rate per square yard {square meter} of the plant mix layers are designed assuming a compacted mix unit weight {mass} of not greater than 158 pounds per cubic foot {2530 kg/m^3} for dense graded mixes (light weight aggregates excepted.) Hence, a correction to the plan designated rate per square yard {square meter} will be made in accordance with the following:

- If the compacted mix density as determined in the job mix formula design exceeds 158 , or is below 130, pounds per cubic foot, {2530 kg/m^3, or is below 2080 kg/m^3}, the correction will be based on the formula: **x = ab/158 {x = ab/2530}**, where
  - x = corrected rate per square yard {square meter},
  - a = laboratory compacted mix unit weight in pounds per cubic foot {density in kilograms per cubic meter} as shown in the job mix formula, and
  - b = project designated rate per square yard {square meter} of plant mix as shown on the job plans.
- If the laboratory compacted density is between 130 pounds per cubic foot and 158 pounds per cubic foot {2080 kg/m^3 and 2530 kg/m^3}, no correction will be made to

the pounds per square yard {kilograms per square meter} designated by the plans or proposal.

- If the plans provide for the use of lightweight aggregate (expanded clay or shale), the pounds per square yard {kilograms per square meter} of the layer shown by the plans or proposal will not be adjusted.
- If the plans provide for the use of an "Open Graded" plant mix layer, the pounds per square yard {kilograms per square meter} of the layer shown by the plans or proposal will not be adjusted.

2. Requirement for Approved Job Mix Formula (JMF).

Work shall not be started under this Section on a specific project until the Contractor has submitted and received approval of a job mix formula from the Materials and Tests Engineer and the job mix formula has been checked by the Area Materials Engineer for use on the project.

A change in aggregate sources will require a new job mix formula before the new material is used. A change in liquid asphalt binder source and anti-stripping agent will be allowed without a new job mix formula provided the design criteria is met by a one-point check of the mixture. The one-point check shall include the Air Void content, VMA, Stability, Flow, and TSR (Tensile Strength Ratio) and may be determined during the production of the mix. However, no change in the grade of liquid asphalt binder will be allowed without the written approval of the Materials and Tests Engineer.

3. Contractor's Responsibility for Job Mix Formula.

Designs for all mixes shall be the responsibility of the Contractor and shall be submitted by the Contractor for approval. Refer to applicable Sections (420, 424, etc.) for design criteria. The submitted formula shall have been designed by a certified technician (Level III - Designer) in a laboratory that has been certified by the Department.

4. Approval of Job Mix Formula by Materials and Tests Engineer.

The Contractor shall submit to the Materials and Tests Engineer, for approval, a Job Mix Formula (JMF) for each mixture to be supplied from a specific plant. The Contractor shall allow at least four weeks for the evaluation and approval of the job mix formula.

The submitted formula shall include any additive by type and trade name and be accompanied by samples from the material sources the Contractor proposes to use in producing the mix. The job mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of liquid asphalt binder to be added to the aggregate, a single percentage of any additive, and a mixing temperature range suitable for the type, grade, etc. of liquid asphalt binder to be used in the mix. Each job mix formula shall be accompanied by a test report from an approved laboratory certifying that all current Departmental design test parameters have been met (copies of the Departmental current design test parameters may be obtained from the office of the Materials and Tests Engineer). There will be no charge for the Department's checking of the Contractor's job mix formula.

The approved job mix formula for each mixture shall be in effect for a maximum of two years from the approval date on the job mix formula or until the Materials and Tests Engineer withdraws approval by written order.

5. Approval of Job Mix Formula by Area Materials Engineer.

At least two full working days prior to beginning the production of asphalt mix for a specific project, the Contractor shall submit a mix design (approved by the Materials and Tests Engineer) to the Area Materials Engineer. The project number shall be inserted on the approved job mix formula. The Area Materials Engineer will review the mix design to determine if the job mix formula is appropriate for the specific project. If the job mix formula is appropriate for the project, the Area Materials Engineer will sign the mix design as being approved, will note the date of approval, and will distribute copies for inspection of the asphalt production.

A copy of this approved job mix formula with the Materials and Tests Engineer's approval and the Area Materials Engineer's approval (with the date of approval) shall be available at the plant any time material is being delivered to the State.

6. Establishment of Delivery Temperature.

The Engineer will check and record the temperature of the mixture upon delivery to the project site. The minimum delivery temperature for warm mix asphalt shall be 220 °F {104 °C}. The minimum delivery temperature for hot mix asphalt shall be 250 °F {121 °C}. The Engineer should monitor the work to ensure that there is not high variability in the delivery temperatures or isolated loads of temperature differentials that appear extreme. For pay items that do not require density as a pay

factor (patching, widening, etc.) and for mixes that do not require density as a pay factor (OGFC, PATB, etc) the Contractor shall provide a +/- 25 ºF {11 ºC} delivery temperature range.

No loads will be accepted at a temperature greater than 350 ˚F {177 ˚C} for hot mix or warm mix asphalt.

7. Conformance to Approved Job Mix Formula.

All mixtures furnished for use on the project shall conform to the approved job mix formulas within the following ranges of tolerances:

- All liquid asphalt binders used shall meet the requirements given in Section 804. See appropriate pay factor table for liquid asphalt binder content requirements.
- The mixing temperature shall not exceed 350 °F {177 °C}.
- Tolerances for 327, 420 and 424 mixes:
    - Plus or minus 7 % for the #4 {4.75 mm} and larger sieve requirements.
    - Plus or minus 4 % for the #8 through #100 {2.36 mm through 150 μm} sieve requirements.
    - Plus or minus 2.0 % for the #200 {75 μm} sieve requirement.

See Section 423 for gradation requirements for 423 mixes.

The initial setting of the controls for all materials shall be those amounts shown on the job mix formula. The above tolerances are provided for slight variations inherent in job control applications. The Contractor shall make changes as necessary to ensure that the mixture produced is as close as practical to the job mix formula.

8. Consistency of Mix Design in Placement of Wearing Layer.

More than one job mix formula may be submitted and approved for a layer of pavement. The placement of the entire wearing layer shall be from the same job mix unless otherwise approved in writing by the Engineer. For layers other than the wearing layer, the Contractor shall notify the Engineer in writing of the mix design change prior to changing production.

(e) Recycled Asphalt Plant Mix (RAP) and Reclaimed Asphalt Shingles (RAS).

1. Compliance with ALDOT-372.

On all projects utilizing recycled/reclaimed material in the mixture, the Contractor's paving operation and RAP and RAS processing shall conform to the requirements given in ALDOT-372. The recycled hot and warm mix asphalt shall be a homogeneous mixture of reclaimed material, new aggregate (fine or coarse aggregate, or a mixture of fine and coarse aggregate) and new liquid asphalt binder material.

2. Allowable Usage of RAP and RAS.

The Contractor shall have the option to use RAP and RAS in accordance with the requirements given in the following table unless shown otherwise on the plans:

ALLOWABLE USE OF RAP AND RAS Maximum Allowable Percent of RAP and RAS by mass of Total Aggregate Content		
Type of Mix	Maximum RAP Content #	Maximum RAP and RAS Content **
327, Plant Mix Bituminous Base	25 %	RAS Not Allowed
327-E, Permeable Asphalt Treated Base	RAP Not Allowed	RAS Not Allowed
420, Open Graded Friction Course	RAP Not Allowed	RAS Not Allowed
423, Stone Matrix Asphalt 424, Superpave (Maximum Aggregate Size ½", ¾", 1", 1 ½")	Surface Layers: 20 % with no more than 15 % containing chert *; All Other Layers: 35 %	Surface Layers: 20 % *; All Other Layers: 35 %
424, Superpave (Maximum Aggregate Size 3/8")	Surface Layers: 20% All Other Layers: 35%	RAS Not Allowed***
* This limitation applies even if the surface layer is to be covered by an Open Graded Friction Course (Section 420). If the aggregate is chert gravel with a bulk specific gravity that is less than 2.550, a maximum of 15 % of the RAP will be allowed. RAP containing chert gravel shall be crushed so that 100 % of the RAP passes the 1/2 inch {12.5 mm} sieve. Additional RAP that does not contain chert gravel may be added to the mixture through a separate feeder. ** RAS shall be limited to 3% by mass of the total aggregate content for surface layers and 5 % by mass of the total aggregate content for all other layers. *** For projects where the ADT is less than 100 or the surface to be paved is non-trafficked, RAS may be allowed at the contents given for the other 424 Superpave maximum aggregate sizes.		

3. Processing and Restrictions for Aggregate in RAP.

RAP used in 3/8 inch {9.5 mm} Section 424 "Superpave" maximum aggregate size mix shall be processed so that 100 % of the RAP passes the 1/2 inch {12.5 mm} sieve. For all other mixes, the maximum size of the aggregate in the RAP shall meet the maximum size for the mix specified. The aggregate in the RAP shall meet the aggregate requirements of the mix it is used in and the requirements given in Sections 801 and 802 (no gravel in Section 327 PATB, Section 420 and Section 423 mixes). RAP used in Section 327 PATB and Section 420 mixes shall be processed so that 100 % of the RAP is retained on the No. 4 {4.75 mm} sieve.

4. Reclaimed Asphalt Shingles (RAS).

Reclaimed Asphalt Shingles (RAS) shall be handled, stored, and used in accordance with the requirements given in ALDOT 372 and the following requirements.

The RAS shall be materials produced as a by-product of the manufacturing process for roofing shingles and/or scrap shingle (from roofing materials).

The RAS shall be free from foreign materials such as paper, nails, wood, and metal flashing. The RAS shall be shredded or ground prior to being incorporated into the mixture. The shredded RAS shall have 100% passing the 1/2 inch {12.5 mm} sieve in any dimension and a minimum of 95% passing the 3/8 inch sieve.

In addition to the requirements set forth in ALDOT-372, RAP stockpiles utilized for job mix formula's with RAP content greater than 25 % shall also meet the following requirements.

ADDITIONAL RAP STOCKPILE REQUIREMENTS FOR RAP USED IN A JOB MIX FORMULA WITH INCREASED RAP CONTENT	
Control Parameter	Standard Deviation*
Asphalt Content	0.5 %
% Passing #200 Sieve	1.5 %
Sieve with 50 % RAP Passing	5.0 %
*Based on a minimum of 10 tests	

Testing for RAP stockpile shall be included as part of the design JMF submittal.

(f) Liquid Asphalt Binder Draindown.

1. Fiber Stabilizer.

A fiber stabilizer is required for some mix types (Section 420, 423, etc). For section 420 mixes the warm mix additive Evotherm 3G may be used in lieu of fibers. A fiber stabilizer may be used on other mix types where asphalt binder cement draindown is a problem. Where RAS is included in the job mix formula, fiber stabilizer shall not be required provided the draindown requirements of 0.30% or less are met when tested at 325˚F {163˚C} and 350˚F {176˚C} in accordance with AASHTO T305.

When fiber or Evotherm 3G is used, the dosage rate shall produce a maximum liquid asphalt binder cement draindown of 0.30 % or less when tested at 325˚F {163˚C} and 350˚F {176˚C} in accordance with AASHTO T305. When fiber is used, the sampling and testing frequency for all mixes for both Contractor and Department testing during production shall be one test for each 5000 tons {metric tons} or portion thereof. The fiber shall be listed on List II-23, Fibers for use in Hot Mix Asphalt (from the Materials, Sources, and Devices with Special Acceptance Requirements (MSDSAR) manual). If pelletized fibers are used, the fiber within the pellet shall be listed on List II-23. All fibers listed on List II-23 shall meet the requirements of either Item 2, 3, or 4 of this Subarticle.

2. Cellulose Fibers.

The maximum length of the fiber shall be 0.25 inches {6.35 mm}. A representative 3 gram sample, when heated in a crucible between 1100 and 1200 °F {595 and 650 °C} for at least 2 hours, shall show between 13 % and 23 % non-volatiles. A representative 5 gram sample, when stirred into 100 ml of distilled water, shall have a pH between 6.5 and 8.5 after sitting for 30 minutes. A representative 5 gram sample, when saturated with mineral spirits for 5 minutes and then sieved for 10 minutes on a No. 40 {425 μm} sieve, shall absorb between 4 % and 6 % its own weight of mineral spirits. A representative 10 gram sample, when weighed and placed into a 250 °F {121 °C} oven for two hours, shall lose less than 5 % by weight when weighed immediately upon removal from the oven.

Sieve analysis of the cellulose fiber shall be either of the following methods:

- Using an Alpine Air Jet Sieve (Type LS), a representative 5 gram sample of the fiber is sieved for 14 minutes at a controlled vacuum of 11 psi {75.8 kPa}. The fibers remaining on the screen are weighed. The results of this analysis shall indicate that 60 % to 80 % of the fiber passes the No. 100 {150 μm} sieve. Or:
- Using a Mesh Screen Analysis, a representative 10 gram sample of the fiber is sieved using a shaker with two nylon brushes on each screen. The results of this analysis shall indicate that the fiber has the following amounts passing the specified screens: 75 % to 95 % on the No. 20 {850 μm} sieve, 55 % to 75 % on the No. 40 {425 μm} sieve, and 20 % to 40 % on the No. 140 {100 μm} sieve.

3. Mineral Fibers.

When tested in accordance with the Bauer-McNett Classifier (BCM) fractionation method process procedure, the fiber length shall have a maximum mean test value of 0.25 inches {6.35 mm}. By using a phase contrast microscope, and a representative test sample of at least 200 fibers, the fiber diameter shall have a maximum mean test value of 0.0002 inches {5.1 μm}. The shot content passing the No. 60 {285 μm} sieve shall be 85% to 95%. The shot content passing the No. 230 {65 μm} sieve shall be 60 % to 80 %. This is a measure of non-fibrous material determined on vibrating sieves (for further information see ASTM C 612).

4. Synthetic Fibers.

Synthetic fibers shall include but are not limited to one or a combination of the following: polyolefins (such as polyethylene and polypropylene) and aramids (such as Kevlar, Twaron and Nomex). Fibers shall be twisted fibrillated, flat fibrillated or monofilament with a maximum fiber length of 0.75 inches {19 mm}

5. Placing Fiber in Mix.

a. Manual Method.

Provided it can be demonstrated to the satisfaction of the Engineer that the proper dosage of the fibers is uniformly distributed into the mix, manual introduction of fibers is acceptable when a batch plant is used to make the mix. When the fibers are available in prepackaged (weighed) containers, proper dosage may be pre-determined per batch. A device is required to interrupt mixture production and warn the plant operator if the operator manually feeding the fiber fails to introduce it properly. Dry mixing time shall be increased at least five seconds to insure adequate

blending. Wet mixing time shall be increased at least five seconds for cellulose fibers and up to five seconds for mineral fibers. Manual introduction of fibers shall not be used in drum plants.

b. Automatic Method.

Methodology and equipment for metering bulk loose and pelletized fiber into asphalt plants has been developed by the fiber suppliers. Whenever the fiber supplier's recommendations are more stringent than this specification, the fiber supplier's recommendations are controlling. This specification requires specialized equipment that can accurately proportion and meter, by weight {mass}, the proper amount per batch (for batch plants) or continuously, in a steady uniform manner (for drum plants). Fiber, pelletized or loose, shall not be fed through the cold feed bins or through the rap bin.

These proportioning devices shall be interlocked with the plant system and controlled to +/- 10% of the weight of the fibers required so as to maintain the correct proportions for all production rates and batch sizes. During the test strip, an equipment calibration check which shows the fiber is being accurately metered and uniformly distributed into the mix shall be performed to the satisfaction of the Engineer. These metering devices shall provide in process high flow (+ 10% or more) and low flow (-10% or less) plant operator notification and interrupt the mix production where the fiber rate is not properly controlled. The fiber metering system shall also provide a record of feed rate (weight or mass per time) and include a section of translucent pipe for visual confirmation of consistent flow rates. Care shall be taken to insure that the fibers are not entrained in the plant's exhaust system. If there is any evidence of fiber in the bag-house or wet-washer fines, the liquid asphalt binder line and/or the fiber line shall be relocated so that the fiber is captured by liquid asphalt binder spray and incorporated into the mix. If there is any evidence of clumps of fibers or pellets at the discharge chute, the contractor shall increase the mixing time and/or intensity. This may entail extending the liquid asphalt binder and fiber feeding lines further into the drum.

(g) Sampling and Inspection.

Aggregates will be accepted in stockpiles in accordance with the Department's Testing Manual provided there is no segregation or contamination, but production of required gradation in the mix shall be the Contractor's responsibility.

Liquid asphalt binder will be accepted in accordance with the requirements given in ALDOT-243.

The right is reserved to take samples, including aggregates from stockpiles, plant mix from the hot elevator, plant mix from the spreader, liquid asphalt binder from storage tanks at the plant, etc., and to make further tests as needed as a basis for continued acceptance of the materials.

Samples of the mixture in use will be taken and tested in accordance with Subarticle 106.09(b).

When directed, the Contractor shall use mechanical equipment to cut samples for testing from the compacted pavement. Samples not smaller than 4 inches {100 mm} square or 4 inches {100 mm} in diameter for the full depth of the course to be tested shall be taken at the locations directed by the Engineer. Furnishing of suitable approved cutting equipment, the cutting of the samples, and the immediate repair of the sample holes with similar type of material shall be performed by the Contractor without extra compensation.

A laboratory shall be furnished for the control of each hot and warm mix asphalt plant in accordance with the provisions of Section 601.

410.03 Construction Requirements.

(a) Equipment.

In general, the choice of equipment will be left to the Contractor. It is the Contractor's responsibility to provide proper sized and amounts of equipment that will produce, deliver to the roadbed, spread, and compact the plant mixed material in sufficient quantities for the continuous movement of the spreaders under normal operating conditions.

The mixing plant, hauling, spreading, and compaction equipment shall meet the requirements listed below; however, other equipment that will produce equally satisfactory results, such as electronically or automatically controlled devices of proven performance, will be considered for use in lieu thereof.

The Contractor shall secure the Engineer's approval of all equipment prior to beginning work and any equipment determined by the Engineer to be unsatisfactory shall be promptly replaced or supplemented.

1. Requirements for all Plants.

Mixing plants shall comply with the requirements of AASHTO M 156 as modified by ALDOT-324, Mixing Plant Requirements for Hot-Mixed, Hot-Laid Asphalt Paving Mixtures. In addition to the above, if a recycled/reclaimed mix is used, the mixing plant shall be modified as necessary to accommodate the use of the reclaimed material and necessary additives. Mixing plants shall be inspected at least annually to insure compliance with the requirements of AASHTO M 156 and ALDOT-324. The Contractor/Vendor will be charged a fee as specified by ALDOT-355, General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements. If the plant is relocated or substantially modified in any way within a year of the last inspection, an additional inspection and related fee will be required.

The plant shall be equipped with a dust collector constructed to waste or store and later return uniformly to the aggregate mixture all or any part of the material collected.

2. Scales.

A digital recorder shall be installed as part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights {masses} of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process, and so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately determine the weight {mass} of the heaviest loaded truck or tractor trailers that are used for the delivery of the hot and warm mix asphalt from that plant.

In lieu of plant and truck scales, the Contractor may provide either (1) an approved automatic printer system which will print the weights {masses} of the material delivered (evidenced by a weight {mass} ticket for each load), provided the system is used in conjunction with an approved automatic batching and control system, or (2) an electronic load cell weight {mass} determination system with associated computer hardware and automated printing system.

The Contractor may provide a "weigh {mass} batcher" system utilizing a weigh {mass} hopper equipped with load cells that determine the net amount of mix delivered from the weight {mass} hopper. An automated weigh {mass} printing system shall be provided to accurately print the weight {mass} of material delivered, the time, and the date for each ticket.

All scales which determine the weight {mass} of the mix for pay purposes shall meet the requirements of Subarticle 109.01(h).

3. Hauling and Remixing Equipment.

a. Load Limitations.

Reference is made to Article 105.12 concerning load limitations on hauling equipment.

Wherever a Material Remixing Device is used, the following restrictions shall apply:

- The device shall be empty while on a bridge.
- The device shall be moved across a bridge without any other vehicles or equipment being on the bridge.
- The device shall be moved on a bridge only within the limits of a lane and shall not be moved on the shoulder of a bridge.
- The device shall move at a speed no greater than 5 miles {8 km} per hour without acceleration or deceleration.

b. Trucks.

Each truck shall have a hole approximately 5/16 of an inch {8 mm} in diameter suitably placed in the side of the body, to allow for temperature measurement of the asphalt mix.

Trucks used for hauling hot and warm mix asphalt mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a minimum amount of approved asphalt release agent (List II-6, Hot Mix Asphalt Release Coating for Truck Beds, in the MSDSAR manual) to prevent the mixture from adhering to the beds. The use of gasoline, kerosene, diesel or other volatile material is prohibited.

Each truck shall be equipped with a tarpaulin that shall be used as needed to protect the mixture from adverse conditions. The tarpaulin shall be made of water repellent material, be of sufficient weight and strength to resist tearing and be in good condition with no holes or tears. The tarpaulin shall be large enough to cover the load.

Mixture shall not leave the plant unless the load is covered when the following conditions exist:

- when the air temperature is below 60 °F {15 °C};
- when hauling time exceeds 30 minutes; or

- when threatening weather is present.

c. Material Remixing Device.

When Pay Item 410-H is included in the contract, a material remixing device shall be used for the placement of all asphalt layers except the following:

- 327-E, Permeable Asphalt Treated Base (PATB);
- A layer placed directly on top of PATB if the placement must be accomplished by operating the remixing device on the PATB.

If a pay item is not shown on the Plans, the Contractor may use a material remixing device without compensation.

A material remixing device shall not be placed on a Permeable Asphalt Treated Base.

The material remixing device shall be capable of remixing plant mix between the trucks and the finished mat. Plant mix shall be remixed in the device prior to being laid by the paver or spreader. The plant mix delivered by the material remixing device shall be a homogeneous, non-segregated mixture.

Equipment known to accomplish this remixing operation and currently approved by ALDOT are listed below:

Manufacturer	Model
Astec	SB 3000
Blaw-Knox	MC-330/TWIN PUG TUB
ROADTEC	Shuttlebuggy SB-1500, SB-2500 MTV-1000D, MTV-1000E
Terex/Cedarapids	CR 662 RM
Weiler	E1250, E1650, E2850

A material remixing device will not be required for the following situations:

- temporary work of short duration,
- bridge replacements having less than 1000 feet {300 m} of pavement at each end of a bridge,
- acceleration and deceleration lanes less than 1000 feet {300 m} in length,
- tapered sections, widening, patching, spot leveling, shoulders, crossovers, side street returns and other areas designated by the Engineer.
- when placing a continuous leveling layer where the thickness of the layer is required to be transversely tapered (i.e. to correct cross slope) to a thickness less than twice the maximum aggregate size of the layer being placed.

The Contractor shall use a hopper insert with a material remixing device if Pay Item 410-H is included in the contract. On projects where Pay Item 410-H is not included in the contract, use of a hopper insert is preferred, but not required.

4. Asphalt Pavers or Spreaders.

Asphalt pavers or spreaders shall be self-contained and of sufficient size, power, and stability to receive, distribute, and strike off the asphalt material at rates and widths consistent with the specified typical section requirements and details shown on the plans and noted in Item 410.03(f)2.

All asphalt pavers or spreaders used for mainline paving, including shoulders and interchange ramps, shall be equipped with a full width vibratory, or other compactive type, screed. The augers used to move the material across the width of the screed shall extend within 1.5 feet {450 mm} of the edge of the screed. It will be permissible to use a hydraulically extendable strikeoff for paving turnouts and short sections of pavement including variable width sections and crossovers.

When laying mixtures, the paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture, providing a finished surface of the required evenness and texture without tearing, gouging, or shoving of the mixture.

All asphalt paving machines shall be operated with automatic grade and slope controls unless otherwise directed by the Engineer. The automatic grade controls shall be a contact ski, a mobile stringline, or non-contact sonic averaging sensors. The effective length of these controls shall be a minimum of 24 feet {7.3 m}. In the event of a malfunction of the automatic control system, the spreading operation shall be discontinued after one hour until the equipment is repaired.

If shown to be required on the plans, special attachments to the pavers and spreaders will be required to shape and finish the pavement.

5. Compaction Equipment.

Compaction equipment shall be capable of compacting the mixture to the required density throughout the depth of the layer while it is still in a workable condition without damage to the material. The Contractor shall be responsible for the selection of the types and number of rollers to be used.

(b) Daylight, Wet Weather, and Temperature Limitations.

1. Operations in Daylight.

Placement and compaction operations shall be performed during daylight hours unless noted otherwise on the plans or directed otherwise by the Engineer. (The requirements for lighting for nighttime work are given in Subarticle 104.04(a)).

2. Wet Weather.

The mixture shall be laid only upon an approved underlying course, which is dry, and only when weather conditions are suitable. The Engineer may, however, permit work of this character to continue when overtaken by sudden rains, up to the amount which may be in transit from the plant at the time, provided the surface just ahead of the placement is swept clear of water and the mixture is within the allowable temperature tolerances. The layer placed under such conditions shall be at the Contractor's risk and shall be removed and replaced by the Contractor without extra compensation should it prove unsatisfactory.

3. Cold Weather Restrictions.

Hot mix asphalt (HMA) layers of 200 pounds per square yard {110 kg/m^2} or less shall not be placed when the surface or air temperature is below 40 ºF {4 ºC}; air temperature shall be 40 ºF {4 ºC} before the spreading operation is started. Spreading operations shall be stopped when the air temperature is below 45 ºF {7 ºC} and falling. For HMA layers over 200 pounds per square yard {110 kg/m^2}, the above temperature may be lowered 5 °F {2 °C}. Unless otherwise stated in the plans and specifications, polymer modified HMA layers of 200 pounds per square yard {110 kg/m^2} or less shall not be placed when the surface or air temperature is below 60 ºF {15 ºC}; for layers over 200 pounds per square yard {110 kg/m^2}, the above temperature may be lowered 10 °F {5 °C}.

Warm mix asphalt (WMA) layers of 200 pounds per square yard {110 kg/m^2} or less shall not be placed when the surface or air temperature is below 32 ºF {0 ºC}; air temperature shall be 32 ºF {0 ºC} before the spreading operation is started. Spreading operations shall be stopped when the air temperature is below 35 ºF {2 ºC} and falling. For WMA layers over 200 pounds per square yard {110 kg/m^2}, the above temperature may be lowered 5 °F {2 °C}. Unless otherwise stated in the plans and specifications, polymer modified WMA layers of 200 pounds per square yard {110 kg/m^2} or less shall not be placed when the surface or air temperature is below 50 ºF {10 ºC}; for layers over 200 pounds per square yard {110 kg/m^2}, the above temperature may be lowered 10 °F {5 °C}.

With the exception of Section 420 "Polymer Modified Open Graded Friction Course" layers and any asphalt mixes containing RAS, the Contractor may place HMA and WMA layers at temperatures lower than the cold weather limits. The Contractor is warned that other factors such as wind speed and percent humidity may increase the heat loss from the HMA and WMA layers. All other requirements for the installation and quality of the HMA and WMA layers shall be applicable to the work even when the restrictions against placement of the HMA and WMA during cold weather are not followed. The layers placed under such conditions shall be at the Contractor's risk and shall be removed and replaced without extra compensation if they are unacceptable. There will be no direct payment for additional costs associated with the placement of HMA and WMA during cold weather.

(c) Preparation of Underlying Surface.

1. General.

The underlying surface must be approved by the Engineer before the placement of a plant mix application will be allowed. The underlying surface, whether an old surface or a new surface, shall be thoroughly cleaned of all foreign or loose material and maintained in such condition in advance of the placement operations.

Failures in existing pavement or base shall be corrected, as noted in Item 410.03(c)2, in advance of the placement of an overlying layer.

A prime coat, when required, shall be placed in accordance with Section 401. Tack coat shall be placed in accordance with Section 405.

2. Patching.

When patching of an existing surface is provided by the plans, the Engineer will examine the pavement surface and designate the area to be patched. The designated areas shall be trimmed to the depth of the unstable material as directed. The loose faulty material shall be picked up and removed from the area. The newly exposed patch area shall be cleaned and treated with prime or tack material as directed before placement of patching material. The hot and/or warm mix asphalt patching material shall be placed and compacted by methods approved by the Engineer until the patch area is filled to the elevation of the surrounding surface. Compaction of the patching material shall be to the degree that further consolidation of the patching material is not anticipated and is acceptable to the Engineer.

3. Leveling.

When leveling of an existing pavement or base is provided by the plans, the surface shall be brought to required grade and cross section with plant mix material. The surface to be treated shall be prepared as noted herein and approved before placing the new material. The plant mix material shall be spread in accordance with the provisions of Item 410.03(f)2 and shall be compacted to the satisfaction of the Engineer.

Leveling shall include the placement of asphalt plant mix layers to correct superevelation when directed.

4. Widening.

When widening is provided by the plans, the widening shall be placed at the locations designated by the plans and/or as directed by the Engineer. The requirements for placing the widening shall be the same, as far as practical, as for the placing of the normal roadway. Compaction of the widening material shall be to the degree that further consolidation of the widening material is not anticipated and is acceptable to the Engineer.

(d) Preparation of Mixtures.

1. Liquid Asphalt Binder.

The liquid asphalt binder material shall be heated in a manner that insures the even heating of the entire mass under efficient and positive control at all times. Any liquid asphalt binder material which, in the opinion of the Engineer, has been damaged shall be rejected.

2. Aggregate.

a. Aggregate Used for Batch Mixing and Continuous Mixing Operations.

All aggregates shall be dried so that the moisture content of the hot and warm mix asphalt at the point of sampling is less than 0.20 % by weight {mass} in accordance with ALDOT-130. The temperature of the aggregate at the dryer shall not exceed 600 ºF {315 ºC}.

When more than two ingredients enter into the composition of the mineral aggregate, they shall be combined as directed.

The aggregate, immediately after being heated, shall be screened into three or more sizes and conveyed into separate bins, ready for batching and mixing with liquid asphalt binder material. However, for mixes using aggregate of 1/2 inch {12.5 mm} maximum size, the number of bins may be reduced to two.

b. Aggregates for Dryer Drum Mixing Operations.

Maintenance of a uniform aggregate gradation is essential for a dryer drum operation; hence, caution and care shall be exercised in stockpiling of materials to avoid segregation.

3. Mixing.

a. Mixing Temperature.

The mixing temperature of HMA and WMA shall be in accordance with the refineries' recommendations, based upon the temperature-viscosity curve, and shall be adequate to produce a mixture in accordance with the specification requirements. The mixing temperature shall not exceed 350 °F {177 °C}.

The mixing temperature for HMA and WMA shall be continuously recorded and delivered to the Engineer on the next working day.

b. Batch Mixing.

The dried mineral aggregate, and measured mineral filler when used, prepared as prescribed above, shall be combined in uniform batches by determining the weight {mass} of and conveying into the mixer the proportionate amounts of each aggregate required to meet the job mix formula.

The largest size aggregate shall be introduced first, then smaller sizes progressively, with mineral filler last, or all mineral components may be added simultaneously. The mineral components shall be thoroughly mixed. The required quantity of liquid asphalt binder material for each batch shall be measured by weight {mass} using scales or a liquid asphalt binder material metering device attached to the liquid asphalt binder material bucket.

After the mineral components have been mixed, the liquid asphalt binder material shall be added and the mixing continued for a period of at least 45 seconds, or longer if necessary to produce a homogeneous mixture. However, if a check by ASTM D 2489 (Ross Method) shows that 95% plus coating is obtained, a shorter mixing time will suffice. The Engineer may then give written permission for a change. Each batch must be kept separate throughout the weight {mass} determining and mixing operations.

The mixture shall be uniform in composition, free from lumps or balls of material containing an excess quantity of asphalt, or from pockets deficient in asphalt.

c. Continuous Mixing.

Components shall be introduced and proportioned volumetrically by continuous methods utilizing equipment specified herein for continuous plants. Amounts of aggregate and liquid asphalt binder material entering the mixer, and the rate of travel through the mixer, shall be so coordinated that a uniform mixture of specified gradation and liquid asphalt binder content will be produced.

d. Dryer-Drum Mixing.

Components shall be proportioned by weight {mass} as noted herein in Item 410.03(a)1 for this method of mixing. Amounts of aggregate and liquid asphalt binder material entering the mixer, and the rate of travel through the mixer, shall be so coordinated that a uniform mixture of specified gradation and liquid asphalt binder content will be produced. An anti-stripping agent may be required to insure adequate coating of the aggregates, if so directed by the Engineer.

4. Recycled Mixtures.

a. New Aggregate Temperature.

The new aggregate shall be super-heated to a temperature such that, when combined with the reclaimed material, the specified discharge temperature is produced; however, in no case shall the temperature of the new aggregate exceed 600 °F {315 °C}.

b. Mixing.

The plant shall be designed and operated so that heat transfer will take place in the mixing unit without damage to, or vaporization of, the liquid asphalt binder material. For batch type plants, a minimum dry mixing cycle of 15 seconds shall be required for the new aggregate and reclaimed material before introduction of the new liquid asphalt binder material. All environmental regulations shall be met as required by Article 107.22.

(e) Transporting the Mixture.

The mixture shall be transported in haul trucks meeting the requirements of Item 410.03(a)3. The equipment shall be in sufficient numbers to deliver the material to the roadbed without delay in the quantity required. Loads shall not be delivered too late in the day to be spread, compacted, and finished during daylight hours, unless nighttime work is allowed as shown on the plans or directed by the Engineer. Loads shall not be delivered at a temperature greater than 350 °F {177 °C} , or less than 220 °F {105 °C} without written permission of the State Materials and Tests Engineer.

(f) Placing the Mixture.

1. Rate of Placement.

The placement rate of plant mix will be specified by the plans; however, this rate may require correction to adjust for the compacted mix unit weight {density} as determined in the job mix formula design as outlined in Subarticle 410.02(b). The Engineer may direct in writing that the designated weight {mass} be increased or decreased in certain areas. It shall be the Contractor's responsibility to place and spread the material uniformly and compact it to such a thickness that will produce the specified rate, separately for each layer of base, binder, and surface, and to maintain a continuing check on tonnage {mass} and yardage {area} throughout the day's operation to insure uniform specified rate.

The unit for checking the average rate shall be approximately 5000 square yards {5000 m^2} to the nearest even truck load. If the last check performed in any day or any section of roadway is between 2000 and 5000 square yards {2000 and 5000 m^2}, this section shall be classified as a unit; if less than 2000 square yards {2000 m^2}, this section shall be added to the previous unit and the revised unit

rechecked. When the initial day's operation is less than 2000 square yards {2000 m^2}, this initial section will be carried over to subsequent days' operations to make a unit of approximately 5000 square yards {5000 m^2}.

In any unit checked, the average rate shall not vary from the specified rate by more than 10 pounds per square yard {5 kg/m^2} for layers of 225 pounds per square yard {120 kg/m^2} or less, and 15 pounds per square yard {8 kg/m^2} for layers greater than 225 pounds per square yard {120 kg/m^2}. On the first applied layer of resurfacing where there is no required milling or leveling, this tolerance is increased to 15 pounds per square yard {8 kg/m^2} for layers of 225 pounds per square yard {120kg/m^2} or less, and 25 pounds per square yard {13 kg/m^2} for layers greater than 225 pounds per square yard {120 kg/m^2}. This tolerance is for providing leeway in equipment adjustment only. A consistent and uncorrected variation from the specified rate, even within this tolerance, will not be allowed without the Engineer's written approval. This tolerance does not apply to patching, leveling, and widening.

If the average rate of any unit is found deficient by more than the above referenced tolerance, the Engineer will determine (1) whether the Contractor shall remove and replace the deficient unit without payment for the removal or the material removed, or (2) whether the Contractor may leave the deficient unit in place and cover it with a layer of the same mix of adjusted maximum size aggregate of not less than 80 pounds per square yard {45 kg/m^2} average. In case (2), the surface layer shall not be feather-edged at the end of the overlay layer, but a sufficient amount of the surface beyond the ends of the deficient unit shall be removed, to a neat line across the pavement, to allow placing the full 80 pounds per square yard {45 kg/m^2} and to make a joint that will meet the surface requirements. There will be no payment for any portion of the overlay needed to bring the total up to the designated average rate for that unit.

If the average rate of any unit is found to exceed the above referenced tolerance, the tonnage {metric tonnage} in the unit that is in excess of the specified rate will be paid for as specified in Subarticle 410.09(a).

Unless otherwise provided in the following sections of these specifications, or shown on the plans, the average rate placed and compacted in one layer shall not exceed 350 pounds per square yard {200 kg/m^2} for base or binder layers, and 225 pounds per square yard {120 kg/m^2} for surface layers. Where the amount to be placed exceeds these limits, it shall be placed and compacted in two or more approximately equal layers or as shown on the plans.

2. Spreading.

a. General.

Spreading of the hot and warm mix asphalt mixture shall be performed by equipment meeting the requirements of Item 410.03(a)4, except as noted in this Item. Approved specialized equipment may be employed to spread the hot and warm mix asphalt material where standard full scale equipment is impractical due to size and irregularity of the area to be paved.

Spreading operations shall be correlated with plant operations and hauling equipment such that the spreading operation, once begun, shall proceed at a speed as uniform and continuous as practical. The continual forward movement of the spreader requires the use of hauling vehicles capable of supplying the spreader with hot and warm mix asphalt material while the spreader is in motion. Repetitive interruptions or stopping of the spreader shall be cause for the Engineer to suspend the work until the Contractor evaluates the cause of the stoppage and has provided a definite action plan for correction of the interruptions. Any interruption will require the thorough check of the area immediately under the spreader and any variances shall be corrected immediately or the material removed and replaced, as directed, without additional compensation.

Material placed in the spreader shall be immediately spread and screeded to a uniform depth so that the specified rate of the mixture required is achieved. Alignment of the outside edges of the pavement shall be controlled by preset control lines, and shall be finished in conformity with these controls.

Any spreading operation, which cannot produce acceptable joints within the surface tolerances and density requirements, shall be cause for requiring the Contractor to modify his operations to include additional spreading equipment.

b. Spreading by Motor Grader.

For areas of a hot and warm mix asphalt plant mix surface inaccessible to the mechanical spreader, patching of pot holes and correcting failures in existing pavement, the plant mix may be

dumped in low areas in the amounts directed, windrowed, spread, and compacted to bring the elevation and section to the desired level.

If shown on the plans, the Contractor shall use a motor grader or a motor grader equipped with a dragbox to perform the spreading for the leveling operation. The motor grader shall be equipped with smooth faced tires. The dragbox, when required, shall be of sufficient size and weight {mass} to effectively shape and level the plant mix and shall be approved by the Engineer prior to use.

c. Spreading by Hand.

For areas inaccessible to mechanical spreading equipment, and when patching potholes and minor pavement failures, hand spreading of the hot and warm mix asphalt mixture may be permitted. The mixture shall be distributed immediately into place by means of suitable tools and spread in a uniformly loose layer.

(g) Compacting.

As soon as the mixture has been spread and has set sufficiently to prevent undue cracking or shoving, rolling shall begin. A delay in the initial rolling will not be tolerated and the initial or breakdown rolling should in general be performed by rolling longitudinally, beginning at the sides and proceeding toward the center of the surface.

When initially constructing any leveling layers, the Contractor, as part of his QC plan, shall establish a rolling pattern using the nondestructive testing devices approved in Section 306 of the Specifications. The device shall either be calibrated to roadway cores or gage counts and shall be used to determine the rolling pattern producing maximum density. Contractor QC personnel shall be on site throughout each day to perform periodic checks and verify that the rolling pattern continually produces the maximum density that is achievable.

When paving abuts a previously placed lane, the longitudinal joint shall be rolled in the first pass. On superelevated curves rolling shall begin at the low side and progress toward the high side.

If any displacement occurs during rolling, it shall be corrected at once. To prevent adhesion of surface mixture to the rollers, the wheels shall be kept adequately moistened with water and a non-foaming detergent, but an excess of water will not be permitted.

Adequate precaution shall be taken to prevent dropping of gasoline or oil on the pavement. In places inaccessible to a roller, compaction shall be obtained with hand or mechanical tampers that produce adequate pressure to obtain the required density.

When the roller is in contact with a bridge deck, vibratory mode shall be turned off and the roller shall operate in static mode only.

Throughout the process of compacting, tests for surface smoothness as required by Article 410.05 and density as required by Section 306 shall be made continuously.

(h) Joints.

1. General.

Placing of hot and warm mix asphalt paving layers shall be as continuous as possible. All joints shall be constructed in such a way as to provide a smooth, well-bonded, and sealed joint meeting the density and surface requirements of Articles 410.04 and 410.05. Failure to meet requirements noted above shall be cause for ordering the removal and reconstruction of the joint without additional compensation.

The contact surface of concrete structures shall be treated with a thin coat of liquid asphalt binder material, tack material, or the liquid asphalt binder material used in the mix, prior to construction of the joint. When directed by the Engineer, the same treatment noted above shall be used on cold asphalt joints.

2. Longitudinal.

Longitudinal joints in the wearing surface shall conform with the edges of proposed traffic lanes, insofar as practical. Any necessary longitudinal joints in underlying layers shall be offset so as to be at least 6 inches {150 mm} from the joint in the next overlying layer.

3. Transverse.

Transverse joints shall be carefully constructed. Rollers shall not pass over the unprotected edge of the freshly laid mixture unless laying operations are to be discontinued. To facilitate the expeditious removal of the plant mix joint when laying operations are resumed, the Contractor shall place a heavy wrapping paper on the underlying surface across the joint and place plant mix on top of the paper.

Upon resumption of the work, a neat vertical joint shall be formed into the previously laid material to expose the full depth of the layer. The fresh mixture shall be raked and tamped to provide a well-bonded and sealed joint meeting surface and density requirements.

410.04 Density Requirements.

Density requirements shall be as specified in Table IV, Subarticle 410.08(e).

410.05 Surface and Edge Requirements.

(a) Surface Smoothness Requirements.

1. General.

Surface smoothness and roadway section will be checked by the use of string, Engineer's level, and straight edge.

The Contractor shall furnish string, straightedges, and the necessary personnel to handle them under the supervision of the Engineer.

Surface smoothness tests shall be made continuously during and immediately after rolling so that irregularities may be eliminated to the extent possible by rolling while the material is still workable; otherwise, deficiencies shall be corrected as provided in Article 410.06.

2. Perpendicular to Centerline of Roadway.

The finished surface of all base, binder, and wearing surface layers shall not vary more than 1/4 of an inch {6 mm} from a 10 foot {3.0 m} straightedge placed perpendicular (at a right angle) to the centerline of the roadway anywhere on the surface.

Unless shown otherwise on the plans, the slope shall not vary by more than 0.20 % from the required slope in any 10 foot {3.0 m} distance over which the slope is measured without the Engineer's written approval. (If, for example, a 2.0 % slope is required, the measured slope shall not be greater than 2.2 % or less than 1.8 %.)

3. Parallel to Centerline of Roadway.

The surface shall not vary more than 1/4 of an inch {6 mm} from a 16 foot {4.8 m} straightedge placed parallel to the centerline anywhere on the surface. A 16 foot {4.8 m} rolling straightedge, equipped with marking capability, may be used in lieu of the fixed straightedge if approved by the Engineer.

The finished surface shall not vary more than 3/8 of an inch {9 mm} in any 25 foot {8 m} section from a taut string applied parallel to the surface at the following locations: 1 foot {300 mm} inside of the edges of pavement, at the centerline, and at other points designated by the Engineer. The variance from the designated grade shall not increase or decrease by more than 1/2 of an inch {12 mm} in 100 feet {30 m}.

(b) Edge Requirements.

Unless shown otherwise on the plans, surface, binder, and leveling pavement edges not confined by curbing or other structures may be lightly tamped behind the placement operation as a preventative measure against cracking and bulging during the rolling process. This procedure shall also be required on the initial edge of a longitudinal cold joint. These edges shall be neatly shaped to line behind the breakdown roller and shall be trimmed as necessary after final rolling, to an accurately lined string or wire providing a maximum tolerance of 2 inches {50 mm} outside the theoretical edge of pavement, with a maximum variation from a true line of 1/2 of an inch {12 mm} in 10 feet {3 m} and a slope not flatter than 1:1. Edges that are distorted by rolling shall be corrected promptly.

(c) Smoothness Requirements.

The smoothness requirements and testing covered in this Subarticle shall apply for pay factor adjustments as indicated in the table below only if Item 410-I Smoothness Testing – Certified Inertial Profiler is included on the plans or in the proposal.

1. Testing Device.

a. Description.

The testing device shall be an inertial profiler that satisfies the requirements of ALDOT-448, “Evaluating Pavement Profiles,” including the portable storage device(s) referenced herein. Portable storage devices containing profile measurements shall become the property of the Department at the time the measurements are taken.

b. Equipment Requirements.

The inertial profiler shall be a certified, non-contact, laser-based device capable of simultaneously measuring both wheelpaths meeting all the requirements of ALDOT-448.

Portable storage device(s) for the inertial profiler shall be furnished in sufficient quantities for all calibration, test runs, and actual tests deemed necessary by the Engineer. Unless approved in advance by the Engineer, all portable storage devices provided by the Contractor will take the form of commonly available 2G USB flash drives.

2. Testing Procedure.

a. Description.

The testing device shall be an inertial profiler that satisfies the requirements of ALDOT-448, "Evaluating Pavement Profiles," including the portable storage device(s) referenced herein. Portable storage devices containing profile measurements shall become the property of the Department at the time the measurements are taken.

	410-I Smoothness Testing – Certified Inertial Profiler
Open Graded Friction Course Layer	Data Collection Required & Pay Factors Apply
Wearing Surface Layer	Data Collection Required & Pay Factors Apply

Smoothness testing shall be performed and reported daily until the contractor demonstrates the ability to achieve a Mean Roughness Index (MRI) value of less than 65 in/mile. If the Contractor demonstrates the ability to achieve a MRI value of less than 65 in/mile then the Contractor may elect to perform and report the smoothness testing at a frequency he determines but not to exceed 5 working days production.

b. Smoothness Requirements.

The results of the inertial profiler tests shall be evaluated by Department personnel as outlined in ALDOT-448.

If a Mean Roughness Index (MRI) value of 90 inches per mile {1.4 m/km} is exceeded in any test section of any daily paving operation, the paving operation will be suspended as soon as possible after results of the unacceptable test section are obtained. The paving will not be allowed to resume until corrective action is taken by the Contractor.

When the MRI is more than 65 inches per mile {1.0 m/km}, per section, a unit price reduction will be assessed. When the MRI is less than 45 inches per mile {0.7 m/km} per section, a unit price increase will be added. The price adjustments are given in Table 1.

TABLE I	
Mean Roughness Index Inches/Mile/Section {meters/Kilometer/Section}	Contract Price Adjustment Percent of Pavement Unit Bid Price
Under 35 {Under 0.6}	105
35 to less than 45 {0.6 to less than 0.7}	105 – (MRI – 35)/2 {105 – (MRI – 0.6)/0.02
45 to less than 65 {0.7 to less than 1.0}	100
65 thru 90 {1.0 thru 1.4}	100 – (MRI – 65)/1.25 {100 – (MRI – 1.0)/0.02}
Over 90 {Over 1.4}	Unacceptable

For Pay Item 410-I, any price adjustment for smoothness considerations will be applied to the theoretical tonnage {metric tonnage}, calculated using the plan specified rate of placement, placed

in those sections testing under 40 in/mile, or more than 65 inches/mile {0.6 m/km, or more than 1.0 m/km} per section.

There will be no payment greater than 100% for any section in which there were transverse joints that have been corrected by grinding per Article 410.06.

410.06 Correction of Deficiencies and Defects.

Deficiencies in surface smoothness as determined in Subarticle 410.05(a) shall be remedied to the extent practicable by rolling while the material is still workable. Otherwise the layer shall be removed and replaced as necessary to obtain required smoothness. "Skin patching" of a surface layer to correct low areas or heating and scraping to correct high areas will not be permitted. Overlays of not less than 80 pounds per square yard {45 kg/m^2} may be authorized by the Engineer for surface smoothness deficiencies provided all material in the overlay is without additional cost to the Department.

Diamond grinding to correct transverse joints may be allowed at the sole discretion of the Engineer. Micro-milling or fine milling may be used to correct joints in underlying layers. Grinding shall not be used on an Open-Graded Friction Course. Slurry and residue from the grinding shall not be allowed to flow across travel lanes or into drainage facilities or adjacent bodies of water. A fog seal shall be applied over any grinding areas in a wearing surface. Placement of the fog seal shall be as directed by the Engineer.

Deficiencies in thickness shall be remedied as specified in Item 410.03(f)1.

All areas containing excessive or deficient amounts of liquid asphalt binder, all areas showing unacceptable segregation of materials, and all areas unbonded after rolling shall be removed and replaced at no cost to the Department. Unacceptable segregation of a hot and warm mix asphalt mat is defined as any area in which two six inch {150 mm} cores are taken and the average percent liquid asphalt binder content of the cores have an absolute difference greater than 0.50 percentage points of the design liquid asphalt binder content, or the combined gradation analysis of the two cores on selected sieves has an absolute difference greater than 10 percentage points from the job mix formula. All testing shall be in accordance with ALDOT-389, "Evaluation of Segregated Areas in Hot Mix Asphalt Pavement." The location of all cores taken for segregation evaluation will be determined by the Department. All coring and traffic control required by ALDOT-389 shall be conducted/supplied by the Contractor at no cost to the Department; however, the Contractor will be reimbursed $500.00 per core when core results are within tolerances and the coring operations require additional traffic control.

At any time that segregation is determined to be unacceptable, work shall be automatically suspended if positive corrective action is not taken by the Contractor to prevent further segregation in the mat. Upon suspension, the Contractor shall place a test section not to exceed 500 tons {500 metric tons} of the affected mixture for evaluation by the Engineer. However, if after a few loads it is apparent that the corrective actions were not adequate, work shall again be suspended and the segregated areas evaluated in accordance with ALDOT-389. Likewise, if after 500 tons {500 metric tons} it is apparent that the problem has been solved, work will be allowed to continue.

When correcting subsurface mixtures (base and binder layers), the removal and replacement may be limited to the actual defective areas or the full mat width within the limits of individual defective areas as directed by the Engineer. Removal and replacement of hot and warm mix asphalt wearing surface layers shall be a minimum of the full mat width and 10 feet {3 m} in length. All surface tolerance requirements shall apply to the corrected areas for both subsurface and surface mixes.

Areas found deficient in density shall be removed and replaced or immediately re-rolled until density is acceptable.

All work specified in this Article shall be performed without additional compensation.

410.07 Maintenance and Protection.

Sections of newly finished work shall be protected from all traffic until properly hardened. Maintenance shall include immediate repairs of any defects that may occur on the work; such repairs shall be repeated as often as necessary to maintain the work in a continuously satisfactory condition. The Contractor shall be responsible for the protection of the work and protection of any traffic using the work. No additional compensation will be paid for maintenance and protection.

410.08 Method of Measurement.

(a) General.

The accepted quantity of hot and warm mix asphalt plant mix used as directed will be measured in tons of 2000 pounds {metric tons} in accordance with the following:

When the laboratory compacted density as determined in the job mix formula design exceeds 158 pounds per cubic foot {2530 kg/m^3}, the actual total tonnage {metric tonnage} of mix placed will be adjusted for pay purposes in accordance with the following formula (this shall not apply to Section 327 PATB and Section 420 OGFC):

$y = 158\ c / a$ { $y = 2530\ c / a$}, where

y = total tonnage {metric tonnage} of plant mix for pay purposes;

c = actual tonnage {metric tonnage} of plant mix measured and placed, except items subject to pay factor adjustment under the QC/QA provisions. On items subject to pay factor adjustment, the adjusted tonnage {metric tonnage} (after pay factor adjustment) will be used;

a = laboratory compacted mix unit weight in pounds per cubic foot {density in kilograms per cubic meter} as shown in the job mix formula.

No adjustments to the actual total tonnage {metric tonnage} placed will be made where the laboratory compacted mix density is below 158 pounds per cubic foot {2530 kg/m^3}.

No adjustments to the actual tonnage {metric tonnage} placed will be made when the use of lightweight aggregate (expanded clay or shale) is designated.

For determining weight {mass}, each load of hot and warm mix asphalt mixture shall have its weight {mass} determined on approved certified scales, as specified in Article 109.01, furnished by the Contractor without direct compensation.

The weight {mass} measurement shall include all components of the mixture. No deductions will be made for any of the components, including the liquid asphalt binder material, contained in the mixture.

The laboratory compacted density requirements for OGFC are given in Section 420. Section 327 PATB does not have a laboratory compacted density requirement because a layer thickness (typically 4 inches {100 mm}) is required instead of a rate of placement.

(b) Acceptance of the Mixture.

The hot and warm mix asphalt mixture will be evaluated at the plant on a LOT to LOT basis. The material will be tested for acceptance in accordance with the provisions of Section 106 and the following requirements. However, any load or loads of mixture, which, in the opinion of the Engineer, are obviously unacceptable, will be rejected for use in the work.

The Contractor shall control all operations in the handling, preparation, and mixing of the hot and warm mix asphalt plant mix so that the percent liquid asphalt binder and voids in laboratory compacted samples or gradation will meet the approved job mix formula within the tolerances shown in Tables II, III, and VI for the 1.00 pay factor. In recognition of the fact that the drying and screening operations may generate additional dust over that shown in the approved mix design, the Contractor's attention is directed to the fact that the dust must be controlled in order to control VMA and voids in the total mix.

Acceptance of the mixture will be in accordance with Subarticle 106.09(c).

LOT pay factors for asphalt content and air voids will be determined from Table II for Section 423 mixes and from Table III for a Section 424 mix after the requirements of Item 106.09(c)3 are satisfied. LOT pay factors for asphalt content will be determined from the top half of Table II for Section 327 and 420 mixes after the requirements of Item 106.09(c)3 are satisfied. Air voids are not a pay factor for Section 327 and 420 mixes. Gradation is shown as a pay factor for Section 420 mixes in Table VI. The pay factor values determined for each sieve noted in Table VI will be averaged. This average will then be compared to the asphalt content pay factor. The lowest of these two pay factors will be applied to the mix.

Calculations for the acceptance test results for asphalt content and voids in total mix shall be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01). Calculations for averages shall be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01) in accordance with ASTM E 29 rules of rounding. LOT pay factors will be calculated to the nearest hundredth (0.01).

Payment for Section 327 and 423 mixes will be on the basis of Table II Acceptance Schedule for Payment. Payment for a Section 424 mix will be on the basis of Table III Acceptance Schedule for Payment. Payment for Section 420 mixes will be on the basis of Table II and Table VI.

(c) Suspension and Voluntary Termination of Lots.

The production process will be considered out of control when any individual test result (asphalt content, gradation, or air voids) from a LOT has a pay factor equal to 0.80 computed from the "1 Test" row in Table II, the “1 Test” row in Table III, or the “1 Test” column in Table VI, whichever is appropriate. When gradation is a pay factor, a 0.80 result for an individual screen (before averaging)

is considered out of control. If any single gradation for the 327 mixes falls outside of the gradation band shown in Section 327 the process is considered out of control. When this happens, production shall be suspended. If mix from the suspended LOT is contained in storage/surge bins, that mix will be considered part of the suspended LOT, and shall not be placed on any State project.

When production is suspended as described above, or when the contractor voluntarily terminates a lot, production shall not be re-started until after all of the following has been accomplished:

(1) the Contractor shall notify the Project Manager immediately that the process is out of control, or that the LOT has been terminated voluntarily, and that production has been suspended;
(2) the Contractor shall determine the appropriate adjustments to make in order to bring the process under control and inform the Project Manager in writing of these adjustments;
(3) after adjustments, the Contractor shall produce a trial batch of mix (approximately 25 to 35 tons {25 to 35 metric tons}) and test for control characteristics (asphalt content, gradation, and air voids);
(4) adjustments, trial batches, and tests shall be repeated as many times as necessary until pay factors for asphalt content, gradation, and air voids equal 1.00, minimum, at which time production may be re-started. Mix utilized as a trial batch shall not be used on the project.

(d) Acceptance Schedule of Payment for Asphalt Plant Mix Characteristics.

TABLE II

SECTION 327 MIXES**
SECTION 420 MIXES (OPEN GRADED FRICTION COURSE)**
SECTION 423 MIXES (STONE MATRIX ASPHALT)

ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS

Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values

Asphalt Content

LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-0.48	0.49-0.51	0.52-0.57	0.58-0.66	Over 0.66
2 Tests	-	0.00-0.34	0.35-0.36	0.37-0.40	0.41-0.47	Over 0.47
3 Tests	-	0.00-0.28	0.29-0.29	0.30-0.33	0.34-0.38	Over 0.38
4 Tests	0.00-0.14	0.15-0.24	0.25-0.26	0.27-0.28	0.29-0.33	Over 0.33

Voids in Total Mix (Lab. Compacted Samples)

LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-1.50	1.51-1.62	1.63-1.80	1.81-2.10	Over 2.10
2 Tests	-	0.00-1.06	1.07-1.15	1.16-1.27	1.28-1.48	Over 1.48
3 Tests	-	0.00-0.87	0.88-0.94	0.95-1.04	1.05-1.21	Over 1.21
4 Tests	0.00-0.45	0.46-0.75	0.76-0.81	0.82-0.90	0.91-1.05	Over 1.05

* If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.

** The Acceptance Schedule of Payment for "Voids in Total Mix" will not apply to the 327 and 420 mixes

TABLE III						
SECTION 424 MIXES (SUPERPAVE)						
ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS						
Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values						
Asphalt Content						
LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-0.62	0.63-0.68	0.69-0.75	0.76-0.88	Over 0.88
2 Tests	-	0.00-0.44	0.45-0.48	0.49-0.53	0.54-0.62	Over 0.62
3 Tests	-	0.00-0.36	0.37-0.39	0.40-0.43	0.44-0.51	Over 0.51
4 Tests	0.00-0.19	0.20-0.31	0.32-0.34	0.35-0.38	0.39-0.44	Over 0.44
Voids in Total Mix (Lab. Compacted Samples)						
LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-2.50	2.51-2.70	2.71-3.00	3.01-3.50	Over 3.50
2 Tests	-	0.00-1.77	1.78-1.91	1.92-2.12	2.13-2.47	Over 2.47
3 Tests	-	0.00-1.44	1.45-1.56	1.57-1.73	1.74-2.02	Over 2.02
4 Tests	0.00-0.75	0.76-1.25	1.26-1.35	1.36-1.50	1.51-1.75	Over 1.75
* If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.						

TABLE VI				
SECTION 420 MIXES (OPEN GRADED FRICTION COURSE)				
ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS				
Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values				
Gradation 3/8" {9.5 mm} Sieve				
LOT Pay Factor	1 Test	2 Tests	3 Tests	4 Tests
1.02	-	-	-	0.00 – 3.60
1.00	0.00 – 12.00	0.00 – 8.48	0.00 – 6.93	3.61 – 6.00
0.98	12.01 – 12.96	8.49 – 9.16	6.94 – 7.48	6.01 – 6.48
0.95	12.97 – 14.40	9.17 – 10.18	7.49 – 8.31	6.49 – 7.20
0.90	14.41 – 16.80	10.19 – 11.88	8.32 – 9.70	7.21 – 8.40
0.80*	Over 16.80	Over 11.88	Over 9.70	Over 8.40
Gradation No. 8 {2.36 mm} Sieve				
LOT Pay Factor	1 Test	2 Tests	3 Tests	4 Tests
1.02	-	-	-	0.00 – 2.40
1.00	0.00 – 8.00	0.00 – 5.66	0.00 – 4.62	2.41 – 4.00
0.98	8.01 – 8.64	5.67 – 6.11	4.63 – 4.99	4.01 – 4.32
0.95	8.65 – 9.60	6.12 – 6.79	5.00 – 5.54	4.33 – 4.80
0.90	9.61 – 11.20	6.80 – 7.92	5.55 – 6.47	4.81 – 5.60
0.80*	Over 11.20	Over 7.92	Over 6.47	Over 5.60
The comparison value for ALDOT and Contractor testing for the 3/8" {9.5 mm} and No. 8 {2.36 mm} sieves is +/- 2.0%. * If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.				

(e) Acceptance of the Roadway Density.

For paving that is not mainline paving (paving for patching, widening, and crossovers and leveling), in-place density pay factors will not be applied. For mainline paving (including shoulders, ramps, and acceleration/deceleration lanes), in-place density pay factors will be applied as specified herein unless otherwise noted on the plans or in the specifications.

After the hot and/or warm mix asphalt mixture has been placed and compacted, it shall be evaluated for density. A core for mat density determination shall be taken by the Contractor on each 3000 foot {900 m} segment of roadway lane of asphalt mixture placed. The location of each test will be designated by the Department. The core shall meet a minimum thickness for use in determining the roadway density. If the core's average thickness in inches {millimeters} is not at least 0.008 times the rate in pounds per square yard {0.375 times the rate in kilograms per square meter}, another core shall be taken (as close a practical to the original location) where the Engineer believes the pavement is thick enough for roadway density determination. The core's average thickness shall be determined by measuring the core's thickness at six equidistant locations around the circumference of the core. The Department will take immediate possession of the core and will make a density determination of the core in accordance with AASHTO T 166, Method A. The density values of the cores will be used to compute the pay factor for that sublot. Testing locations will be selected with the random number method outlined in ALDOT-210. Contractors are allowed, but not required, to take cores anywhere, anytime for quality control. This includes taking cores from the wearing layer. The contractor must have the permission of the Engineer to take cores from a PATB (327) or OGFC (420) mix. All core holes shall be promptly repaired at the contractor's expense. For purposes of evaluation, a LOT will be as defined in Item 106.09(c)1. A SUBLOT for evaluation of density will be equal to 12,000 feet {3600 m} (4 test results) or fraction of a 12,000 foot {3600 m} length as applicable. For instance, a 27,000 foot {8100 m} LOT would be divided into two 12,000 foot {3600 m} SUBLOTS and one 3000 foot {900 m} SUBLOT.

The in-place density will be expressed as a percentage of the theoretical maximum density (TMD) of the mix with the following relationship:

$$\% \text{ TMD} = \frac{\text{In Place Density}}{\text{Maximum Mix Density}} \text{ X } 100$$

Maximum mix density is equated to maximum mix specific gravity as measured with AASHTO T 209, Flask determination with dry back. The maximum mix specific gravity used will be the average of the values from the four most recent determinations using Contractor data.

The appropriate pay factor for each SUBLOT will be determined from Table IV for the appropriate number of test results. The pay factor for the LOT will be determined by computing the weighted average of the SUBLOTS:

$$\text{LOT Pay Factor (PF)} = \frac{\text{PF SUBLOT 1 (Length SUBLOT 1) + PF SUBLOT 2 (Length SUBLOT 2) + …}}{\text{Length SUBLOT 1 + Length SUBLOT 2 + …}}$$

Calculations for the acceptance test results for in-place density will be carried to the hundredths (0.01) and rounded to the nearest tenth (0.1). LOT and SUBLOT pay factor calculations will be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01) in accordance with ASTM E 29 rules of rounding.

The low rates of placement at which minimum density does not apply are given in Section 306. Density pay factors will not be applied to pavement layers placed at these rates.

TABLE IV
ACCEPTANCE SCHEDULE OF PAYMENT FOR IN-PLACE DENSITY

SECTION 423 MIXES (STONE MATRIX ASPHALT)					
Characteristic	SUBLOT PAY FACTOR	Arithmetic Average of the Absolute Values of Deviations of SUBLOT Acceptance Tests From Target**			
		1 Test	2 Tests	3 Tests	4 Tests
In-Place Density	1.02	0.00 - 2.00	0.00 - 1.41	0.00 - 1.15	0.00 - 1.00
	1.00	2.01 - 3.33	1.42 - 2.36	1.16 - 1.92	1.01 - 1.67
	0.98	3.34 - 3.60	2.37 - 2.55	1.93 - 2.08	1.68 - 1.80
	0.95	3.61 - 4.00	2.56 - 2.83	2.09 - 2.31	1.81 - 2.00
	0.90	4.01 - 4.67	2.84 - 3.30	2.32 - 2.69	2.01 - 2.33
	0.80*	Over 4.67	Over 3.30	Over 2.69	Over 2.33
SECTION 424 MIXES (SUPERPAVE)					
Characteristic	SUBLOT PAY FACTOR	Arithmetic Average of the Absolute Values of Deviations of SUBLOT Acceptance Tests From Target**			
		1 Test	2 Tests	3 Tests	4 Tests
In-Place Density	1.02	0.0-2.25	0.0-1.59	0.0-1.30	0.0-1.12
	1.00	2.26-3.75	1.60-2.65	1.31-2.17	1.13-1.88
	0.98	3.76-4.05	2.66-2.86	2.18-2.34	1.89-2.02
	0.95	4.06-4.50	2.87-3.18	2.35-2.60	2.03-2.25
	0.90	4.51-5.25	3.19-3.71	2.61-3.03	2.26-2.62
	0.80*	Over 5.25	over 3.71	over 3.03	Over 2.62

* If approved by the Department, the Contractor may accept the indicated partial SUBLOT pay. The Department may require removal and replacement. The Contractor has the option to remove at no cost to the Department and replace at contract unit bid price rather than accepting the reduced SUBLOT payment.

** Target density shall be 94.0 % of the theoretical maximum density for all mixes except for:
- the range of placement rates given in Item 306.03(g)3 (140 pounds per square yard or greater {76 kg per square meter or greater} and less than 200 pounds per square yard {109 kg per square meter} over surface treatments) the target density shall be 92.0 % and;
- ESAL Range A and B mixes where the Contractor demonstrates and explains in writing why 94 % of the theoretical maximum density cannot be achieved and the Engineer informs the Contractor by written notification that the target density can be reduced to 93 % or 92 %.

TABLE V COMPARISON OF ALDOT AND CONTRACTOR TESTING	
TEST	ACCEPTABLE
ASPHALT CONTENT	± 0.30 %
AIR VOIDS	± 0.50 %
GRADATION *	See Table VI
* Gradations given in Articles 327.02 and 420.02.	

(f) Tack Coat.

Tack coat liquid asphalt material will be measured and paid for as specified in Section 405.

(g) Wasted and Excess Materials Applied.

Deductions in measurement will be made for all material wasted or lost due to negligence of the Contractor or applied beyond the limits of the work.

(h) Material Remixing Device.

The number of material remixing devices measured for payment will be the number of units approved by the Engineer for use. These devices will be measured per each device.

(i) Certified Inertial Profiler.

The number of certified inertial profilers measured for payment will be the actual number of units ordered and accepted.

410.09 Basis of Payment.

(a) Unit Price Coverage.

Compensation for plant mix material, measured as provided above, will be made on a tonnage {metric tonnage} basis and the contract unit price per ton {metric ton} for each individual item shall be full compensation for construction of the hot and warm mix asphalt plant mix layer complete in place on the roadbed as specified or directed, including all materials, procurement, handling, hauling, and processing cost, and includes all equipment, tools, labor, and incidentals required to complete the work.

Unless otherwise covered by a separate pay item, the cost of excavation for patching and widening, compacting the subgrade, backfilling, spreading, or disposing of excess excavated material, removal and disposal of old pavement, removal and resetting of roadway signs and mailboxes, and removal and disposal of pavement markers shall be subsidiary obligations of the associated plant mix pay item, and no additional payment will be made for performing the work.

No payment will be made for unacceptable material; for material needed to overlay layers deficient in thickness; for material used in replacing defective or condemned construction; for material wasted in handling, hauling, or otherwise; or for maintaining the work.

When the average rate of placement is found to exceed the tolerance given in Item 410.03(f)1., the tonnage {metric tonnage} placed above the specified rate in that unit will be paid for at 50 percent of the contract unit price. This reduction will not be applied to patching, leveling, and widening.

Smoothness testing, measured with a certified inertial profiler as noted above, will be paid for at the contract unit bid price which shall be full compensation for furnishing the inertial profiler and portable storage device(s) and includes all equipment, tools, labor, calibration, maintenance, services, supplies, and incidentals necessary to complete these items of work.

The number of approved remixing devices, measured as noted above, will be paid for at the contract unit bid price. This price shall be full compensation for furnishing the vehicles and shall include all equipment, tools, labor, calibration, maintenance, services, operator, and all other items necessary to furnish and operate the vehicles.

(b) Payment will be made under Item No.:

See Appropriate Section for Type of Plant Mix Involved.
410-H Material Remixing Device - per Each
410-I Smoothness Testing - Certified Inertial Profiler-per Each

SECTION 420
POLYMER MODIFIED OPEN GRADED FRICTION COURSE

420.01 Description.

The work covered by this Section shall consist of constructing a hot mixed, hot laid polymer modified open graded friction course wearing layer generally placed on an existing pavement. The typical cross section and the average weight per square yard will be shown on the plans. Requirements for all hot mix asphalt pavements as specified in Section 410 are applicable to this Section, subject to any exceptions contained herein. Quality Control/Quality Assurance (QC/QA) requirements as specified in Section 106 are applicable to this Section, subject to any exceptions contained herein.

420.02 Materials.

The materials furnished for use shall comply with the requirements of Section 410 and the following:

(a) Aggregates.

The aggregate shall be limited to 100% crushed aggregates of the following: granite, quarried quartzite, slag, sandstone or manufactured lightweight aggregate, all of which shall be from approved sources and meet the appropriate requirements of Sections 801 and 802. However, if additional dust (- 200 {- 75 μm} material) is needed, mineral filler (meeting the requirements of Section 805) or agricultural limestone may be used. If agricultural limestone is used, it shall meet the requirements of ASTM C 602, Standard Specification for Agricultural Liming Materials, for Class E agricultural limestone, so that a minimum of 80.0 % of the material will pass the No. 8 {2.35 mm} sieve and 25.0 % will pass the No. 60 {0.250 mm} sieve. In addition, a minimum of 5.0 % will pass the No. 200 {75 μm} sieve. No more than 10.0 % agricultural limestone shall be used.

The aggregate shall be combined into a total blend that will produce an acceptable job mix within the gradation limits shown in the following table. The blend shall be made from at least two stockpiles of different gradations. At least 10% of the blend shall be taken from each stockpile.

AGGREGATE GRADATION FOR OPEN GRADED FRICTION COURSE	
Sieve (Square Mesh Type)	Percent Passing By Weight {Mass}
3/4 inch {19.0 mm}	100
1/2 inch {12.5 mm}	85 - 100
3/8 inch {9.5 mm}	55 – 65
No. 4 {4.75 mm}	10 - 25
No. 8 {2.36 mm}	5 - 10
No. 200 {75 μm}	2 - 4

As stated in Article 410.02 no RAP or RAS is Allowed.

(b) Liquid Asphalt Binder.

The liquid binder shall be a polymer modified PG 76-22 meeting the requirements of Section 804. The proportion of liquid asphalt binder to total sample by weight {mass} shall be 6.0 % to 9.0 %. The exact proportion shall be fixed by the job mix formula.

Additives or modifiers shall be used to prevent stripping of liquid asphalt binder. These additives or modifiers shall be furnished and used at no additional cost to the State.

(c) Polymer.

The polymer additive shall meet the requirements of Section 811.

(d) Liquid Asphalt Binder Draindown.

A fiber stabilizer or Evotherm 3G meeting the requirements given in Section 410 shall be incorporated into the mix to produce a maximum liquid asphalt binder cement draindown of 0.30 % or less when tested at 325°F {163°C} and 350°F {176°C} in accordance with AASHTO T305. The fiber shall be blended into the mix in accordance with the requirements given in Section 410.

(e) Tack Coat Materials

Tack coat materials shall either be a CQS-1hp asphalt emulsion used in conjunction with the spray paver equipment as required in Subarticle 420.04 (d) or "PG Asphalt for Trackless Tack" with conventional paving equipment. All tack coat materials shall meet the requirements given in Section 804 except as modified by the requirements given herein. The CQS-1hp shall be smooth and homogeneous and shall meet the requirements shown in the following table:

CQS-1hp MODIFIED ASPHALT EMULSION			
TEST OF EMULSION			
Parameter	Test Method	Value	
Viscosity @ 77° F, SF	AASHTO T 59	20 Min.	150 Max.
Sieve Test, %	AASHTO T 59	-	0.1 Max.[1]
24-Hour Storage Stability, %	AASHTO T 59	-	1.0 Max. [2]
Residue By Distillation	AASHTO T 59	60 Min.	-
Oil Distillate, by Volume of Emulsion, %	AASHTO T 59	-	-
Particle Charge	AASHTO T 59	Positive [3]	
TEST OF RESIDUE FROM EMULSION			
Solubility in TCE, %	AASHTO T 44 [4]	97.5 Min.	-
Elastic Recovery @ 50 °F	AASHTO T 301	60.0 Min.	-
Penetration @ 77 °F	AASHTO T 49	60 Min.	110 Max.
Ductility @ 77.0 °F	AASHTO T 51	40 Min.	-

1. Sieve test may be waived based on successful application in the field.
2. After standing undisturbed for 24 hours, the surface shall show no white, milky-colored substance, but shall be a smooth homogeneous color throughout the sample.
3. If the Particle Charge Test is inconclusive, a pH test (AASHTO T 200) shall be used with a maximum of 6.7 allowable.
4. ASTM D 5546 may be used when polymers block the filter during the test.

The original "PG Asphalt for Trackless Tack" (no RTFO or PAV testing) shall conform to the physical requirements shown in the following table:

SPECIFICATIONS FOR PG ASPHALT FOR TRACKLESS TACK		
Parameter	Specification	Test Method
Rotational Viscosity	Maximum 3 Pa•s @ 135 °C	AASHTO T 316
Penetration	Maximum 25 @ 77 °F {25 °C}, 100 g. 5s	AASHTO T49
Softening Point (°C)	Minimum 70	AASHTO T 53
Dynamic Shear, G*/sin δ	Minimum 1.0 kPa @ 82 °C	AASHTO T 315

420.03 Design

The Open Graded Friction Course shall be designed with a minimum air void content of 12% according to ALDOT-259, OPEN GRADED ASPHALT CONCRETE FRICTION COURSE DESIGN METHOD. The contractor shall have the responsibility for the design of Section 420 mixes. The laboratory compacted density as determined in the job mix formula design shall not exceed 150 pounds per cubic foot {2400 kg/m^3}; this corresponds with a maximum specific gravity value of 2.837 or a bulk specific gravity of 2.411.

The work will be accepted on a LOT by LOT basis in accordance with the applicable requirements. Pay factors for air voids and density shall not apply.

420.04 Construction Requirements.

(a) General.

The requirements of Articles 410.03 through 410.07 shall apply except as modified hereinafter in this Article.

(b) Rate of Placement of Tack Coat.

The rate of application of the tack coat on the asphalt surface shall be 0.13 to 0.18 gallons per square yard within a tolerance of -0.02 and +0.02 gallons per square yard for the PG Asphalt for Trackless Tack. CQS-1hP asphalt emulsion shall be applied at a rate of 0.18 - 0.23 gallons per square

yard within a tolerance of -0.02 and +0.02 gallons per square yard. A uniform distribution of tack coat across the mat shall be enforced and streaked tack shots shall not be accepted.

(c) Conventional Paving Equipment with the use of "PG Asphalt for Trackless Tack"

The use of conventional paving equipment shall be allowed when the tack coat material used is "PG Asphalt for Trackless Tack" meeting the requirements given in Subarticle 420.02. "PG Asphalt for Trackless Tack" shall be applied at a temperature of 300 °F to 375 °F, on a clean dry surface.

(d) Spray Paver Paving Equipment with the use of CQS-1HP Asphalt Emulsion

The requirements given in Article 410.03 shall be applicable to the construction of the open graded friction course except for the following:

- The paving machine shall incorporate a tack distribution system, receiving hopper, feed conveyor, and a variable width, heated, ironing or vibratory type screed.
- The tack distribution system shall include metered mechanical pressure sprayer to accurately apply and monitor the rate of application of the emulsion for the tack. The rate shall be uniform across the entire paving width. It shall be applied at a temperature of 140 – 180 °F. Application shall be immediately in front of the screed unit. No wheel or other part of the paving machine shall come in contact with the tack before the paving mix is applied.
- Extensions added to the screed shall be provided with the same heating capability as the main screed unit, except for use on variable width tapered areas as approved by the Engineer.

(e) Compaction Equipment.

Item 410.03(a)5 is amended to require that steel wheel tandem (7 ton {6 metric ton} minimum size) rollers shall be furnished in sufficient numbers based on the quantity of material being placed to provide effective compaction coverage within the workable time period of the mix as designated by the Engineer. Rubber-tire rollers shall not be used.

(f) Weather and Temperature Limitations.

The weather, air, and surface temperature limitations for (polymerized) HMA mixes are found in Subarticle 410.03(b).

(g) Compacting.

Subarticle 410.03(g) is amended to require that rolling shall be as approved by the Engineer; no density tests will be required.

420.05 Method of Measurement.

The accepted quantities of polymer modified open graded friction course will be measured as provided in Article 410.08.

The CQS-1hp emulsion or "PG Asphalt for Trackless Tack" for the tack coat will be measured in gallons in accordance with the requirements given in Article 109.02.

420.06 Basis of Payment.

(a) Unit Price Coverage.

Polymer Modified Open Graded Friction Course, measured as noted above, will be paid for at the contract unit price bid in accordance with Article 410.09.

The unit price of the Open Graded Friction Course Tack Coat shall be full compensation for all materials, equipment, and labor required to furnish and place the tack.

(b) Payment will be made under Item No.:

420 - A Polymer Modified Open Graded Friction Course – per ton {metric ton}
420 - B Open Graded Friction Course Tack Coat – per gallon

SECTION 423
STONE MATRIX ASPHALT (SMA)
(FIBER STABILIZED ASPHALT CONCRETE)

423.01 Description.

The work covered by this Section shall consist of constructing a hot mix asphalt layer of fiber stabilized stone matrix asphalt pavement on a prepared surface in accordance with these specifications

and in conformity with the lines, grades, typical cross section, and the placement rate shown on the plans or as directed. The plant, equipment, and construction requirements for this pavement are specified in Sections 106 and 410, subject to any exceptions herein. All 423 mixes shall be designed and produced in accordance with the requirements given in this Section and ALDOT-395, SMA Mix Design.

423.02 Materials.

(a) Aggregates.

1. Procedure for Acceptance of Coarse and Fine Aggregates.

All fine and coarse aggregate furnished shall come from an approved producer who is participating in and meeting the requirements of ALDOT-249, *Procedure for Acceptance of Coarse and Fine Aggregates*. The producer's name shall be listed in the Department's *Materials, Sources, and Devices with Special Acceptance Requirements Manual*, List I-1. The Department has established a list of qualified producers of fine and coarse aggregates. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

2. Types of Acceptable Coarse Aggregates for SMA.

Coarse aggregate shall be aggregate retained on the No. 4 {4.75 mm} sieve. The virgin coarse aggregate shall be 100% crushed granite, quarried quartzite, limestone, sandstone, slag, or other 100% crushed manufactured stone meeting the requirements given in Section 801.

3. Flat and Elongated Particles in Coarse Aggregates for SMA.

The maximum amount of flat and elongated particles in coarse aggregate for SMA is given in the following table.

PERCENT OF FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE FOR SMA		
Test Method		Maximum
Flat & Elongated % by Count 3:1 (max to min)	ASTM D 4791 Section 8.4	20 %
Flat & Elongated % by Count 5:1 (max to min)	ASTM D 4791 Section 8.4	5 %

4. Coarse Aggregate Soundness for SMA.

The percent degradation of the source aggregate by the sodium sulfate soundness test (AASHTO T 104, Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate*)* after five cycles of testing shall not exceed 10 %.

5. Deleterious Materials and Absorption in Coarse Aggregate for SMA.

The amount of deleterious substances and absorption in the coarse aggregate shall not exceed the limits given in the following table.

DELETERIOUS MATERIALS AND ABSORPTION IN COARSE AGGREGATE FOR SMA	
Coal and Lignite (Visual)	0.25 %
Clay Lumps and Friable Particles (AASHTO T 112)	0.25 %
Other local deleterious substances (Shale, Mica, Marcasite, etc.) (Visual)	2.0 %
Absorption (Absorption on the material passing the 3/4 inch {19.0 mm} sieve and retained on the No. 4 {4.75 mm} sieve) (AASHTO T 85 *). Applies to gravel aggregates only.	2.0 %
* Section 8.1 of AASHTO T 85 modified to require a 15 minute vacuum saturation period as per Section 6.3 of AASHTO T 209 prior to the required 15-19 hour soaking period.	

6. Los Angeles Abrasion Criteria for Coarse Aggregate for SMA.

The percent loss of the coarse aggregate by the LA Abrasion test (AASHTO T 96, Resistance to Abrasion of Small Size Aggregate by use of the Los Angeles Machine*)* shall not exceed 48 % except that, for Sandstone and Blast Furnace Slag, the LA Abrasion shall not exceed 55 %.

7. Fine Aggregate for SMA.

Fine aggregate shall be 100% crushed granite, limestone, sandstone, slag, or other 100% crushed manufactured stone meeting the requirements of Section 802 and the following table. The parent material shall meet the requirements given in Section 801.

FINE AGGREGATE QUALITY REQUIREMENTS FOR SMA		
Test Method	Minimum	Maximum
Uncompacted Voids %, AASHTO T 304*	45 %	100 %
Sand Equivalent %, AASHTO T 176*	50 %	100 %
Liquid Limit %, AASHTO T 89	0 %	25 %
Plasticity Index, AASHTO T 90	Non-plastic	
*The Sand Equivalent and Uncompacted Voids may be run on the blend of the aggregates.		

The fine aggregate shall be non-plastic when tested in accordance with AASHTO T 89, as modified by ALDOT-232, and AASHTO T 90 and shall have a maximum of 1.0 % clay lumps and friable particles as determined by AASHTO T 112. It shall consist of hard, tough grain, free of injurious amounts of clay, loam, or other deleterious substances.

8. Mineral Filler for SMA.

The mineral filler shall meet the requirements of Section 805.

(b) Recycled Asphalt Pavement (RAP) & Reclaimed Asphalt Shingles (RAS).

The requirements for allowing the use of RAP and RAS are given in Article 410.02.

(c) Blend of Aggregates.

The combined aggregates shall conform to the percent passing by volume requirements given in the following table.

PERCENT PASSING BY VOLUME OF AGGREGATE FOR SMA										
	1.5 inch {37.5 mm} Maximum Aggregate Size		1 inch {25.0 mm} Maximum Aggregate Size		3/4 inch {19.0 mm} Maximum Aggregate Size		1/2 inch {12.5 mm} Maximum Aggregate Size		3/8 inch {9.5 mm} Maximum Aggregate Size	
Sieve Size	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit
1.5 inch {37.5 mm}	100	100								
1 inch {25.0 mm}	90	100	100	100						
3/4 inch {19.0 mm}	30	86	90	100	100	100				
1/2 inch {12.5 mm}	26	63	50	74	90	100	100	100		
3/8 inch {9.5 mm}	24	52	25	60	26	78	90	100	100	100
# 4 {4.75 mm}	20	28	20	28	20	28	26	60	90	100
# 8 {2.36 mm}	16	24	16	24	16	24	20	28	28	65
# 16 {1.18 mm}	13	21	13	21	13	21	13	21	22	36
# 30 {600 μm}	12	18	12	18	12	18	12	18	18	28
# 50 {300 μm}	12	15	12	15	12	15	12	15	15	22
# 200 {75 μm}	8	10	8	10	8	10	8	10	12	15

An example of how to blend aggregate based upon volume can be found in ALDOT-395, SMA Mix Design. The production tolerances for the above gradation bands are as specified in Item 410.02(d)7, except that the tolerance for the No. 4 {4.75 mm} sieve is +/- 4% and for the 3/8 inch {9.5 mm} sieve is +/- 6%.

Aggregates that tend to polish under traffic, such as limestone, dolomite, or marble, shall be permitted only in widening as defined by Article 410.01, shoulder paving, underlying layers, and layers that are to be covered by Polymer Modified Open Graded Friction Course (Section 420) mix in this contract, except as noted in the following table.

ALLOWABLE CARBONATE STONE CRITERIA FOR SMA	
BPN 9 Value Of Aggregate Source *	Maximum Allowable Percentage Of Carbonate Stone
≤ 25	30
26 through 28	35
29 through 31	40
32 through 34	45
≥ 35	50
* This value, BPN 9, is made using the British Pendulum Tester on aggregate source specimen polished for 9 hours on an accelerated polishing machine known as the British Wheel as per ASTM D 3319, ASTM E 303 and BMTP-382.	

In no case shall the total amount of virgin carbonate stone in the combined mixture used as actual wearing surface layers exceed the percentage shown in the table above. When parts of the carbonate stone used in the mix are from differing strata of material or coming from multiple sources that are represented by different BPN 9 values, the lowest BPN 9 value will be used.

(d) Liquid Asphalt Binder.

1. Required Type of Liquid Asphalt Binder for SMA.

Unless otherwise shown on the plans, for pavement layers in the top 2 inches the liquid asphalt binder shall meet the requirements of Section 804 and shall be polymer-modified to meet a PG 76-22 as given in Section 811. For pavement layers below the top 2 inches the liquid asphalt binder shall be PG 67-22 and shall meet the requirements of Section 804. If Open Graded Friction Course (Section 420) layers are required, the top 2 inches shall be measured from the bottom of the Open Graded Friction Course layer.

2. Required Minimum Amount of Liquid Asphalt Binder for SMA.

The minimum liquid asphalt binder content shall be as given in the following table (by weight {mass} of total mix.

MINIMUM LIQUID ASPHALT BINDER CONTENT FOR SMA			
Maximum Aggregate Size (inches) {mm}	Nominal Aggregate Size (inches) {mm}	Minimum Liquid Asphalt Binder Content (% by weight) {% by mass}	Minimum Liquid Asphalt Binder Content for mixes containing RAS (% by weight) {% by mass}
1.5 {37.5}	1.0 {25}	5.3	5.5
1.0 {25.0}	3/4 {19.0}	5.5	5.7
3/4 {19.0}	1/2 {12.5}	5.7	5.9
1/2 {12.5}	3/8 {9.5}	5.9	6.1
3/8 {9.5}	No. 4 {4.75}	6.1	6.3

3. Liquid Asphalt Binder Draindown.

A fiber stabilizer meeting the requirements given in Section 410 shall be incorporated into the mix to reduce draindown. The fiber shall be blended into the mix in accordance with the requirements given in Section 410. RAS may be allowed as a fiber stabilizer provided it meets the requirements in Section 410.

423.03 Design.

All SMA mixes shall be designed according to ALDOT-395, SMA Mix Design. SMA mixes shall be designed using a 50 blow Marshall design or a 60 gyration gyratory compactor design. The SMA shall have a minimum VMA of 17, a VCA_{MIX} less than the VCA_{DRC} (calculating Voids in the Coarse Aggregate is explained in ALDOT-395 SMA Mix Design) and air voids of 3.5% for SMA mixes containing RAS or 4.0 % for all other SMA mixes. The SMA mix shall be designed with a minimum tensile strength ratio of 0.80 according to ALDOT-361. All SMA mixes shall be tested for susceptibility to rutting in accordance with the latest approved version of AASHTO T 324 Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures. All Mixes shall be tested at 50°C. SMA mixes using PG 67-22 binder shall exhibit 10 mm rutting or less at 10,000 cycles. SMA mixes using PG 76-22 binder shall exhibit 10 mm rutting or less at 20,000 cycles.

423.04 Hot Mix Asphalt Plant Requirements.

(a) Mineral Filler.

To ensure accurate metering and proportioning, the introduction of the mineral filler shall be in accordance with Section 4.3 of AASHTO M 156 as specified in ALDOT-324. Adequate dry storage shall be provided for the mineral filler. In a batch plant, mineral filler shall be added directly into the weigh hopper. In a drum plant, mineral filler shall be added directly into the drum mixer near enough to the liquid asphalt binder line so that the mineral filler is captured by the liquid asphalt binder. Note: For most SMA projects, the flow rate of the mineral filler governs the plant production rate.

(b) Hot-Mixture Storage.

SMA shall be stored according to the requirements as given in ALDOT 324, "Plant Requirements for Plants Producing Hot-Mixed, Hot-Laid Asphalt Mixtures". SMA shall not be heated above 350 °F {177 °C} without the approval of the Engineer.

423.05 Construction Requirements.

(a) General.

Construction requirements shall be the same as specified in Articles 410.03 through 410.07 except as noted in this Article.

(b) Weather and Temperature Limitations.

The weather, air and surface temperature limitations for (polymerized) HMA mixes are found in Subarticle 410.03(b).

(c) Surface Preparation.

A thin tack coat meeting the requirements of Section 405 shall be applied to ensure uniform and complete adherence of the overlay.

(d) Compaction.

Due to the nature of stone matrix asphalt mixture, the surface shall be rolled immediately. Rollers shall move at a uniform speed, not to exceed 3 miles per hour {5 km/hr}, with the drive roller nearest the paver. Rolling shall be continued until all roller marks are eliminated and the required density has been obtained. The Contractor shall monitor density during the compaction process using the nondestructive testing devices approved in Section 306 of the Specifications to ensure that the required density is being obtained. The device shall either be calibrated to roadway cores or gage counts and shall be used to determine the rolling pattern producing maximum density. If vibratory compaction causes aggregate breakdown or forces liquid asphalt binder to the surface, the vibratory mode shall be turned off and the roller shall operate in static mode only.

To prevent adhesion of the mixture to the rollers, it shall be necessary to keep the rollers properly moistened with water mixed with very small quantities of detergent or other approved material.

423.06 Method of Measurement.

The accepted quantities of stone matrix asphalt binder layer and stone matrix asphalt wearing layer will be measured as provided in Article 410.08. The SMA mix shall be evaluated for liquid asphalt binder content, laboratory compacted air voids, and in-place density; pay factors will be applied.

423.07 Basis of Payment.

(a) Unit Price Coverage.

Stone Matrix Asphalt Binder Layer and Stone Matrix Asphalt Wearing Layer, measured as noted above, will be paid for at the contract unit price bid in accordance with Article 410.09.

(b) Payment will be made under Item No.:

423-A Stone Matrix Asphalt Wearing Layer, __*__ Maximum Aggregate Size - per ton {metric ton}
423-B Stone Matrix Asphalt Binder Layer, __*__ Maximum Aggregate Size - per ton {metric ton}
* Specify Maximum Aggregate Size, either 1.5, 1, 3/4, 1/2 or 3/8 inches {37.5 mm, 25 mm, 19 mm, 12.5 mm, or 9.5 mm}

SECTION 424
SUPERPAVE BITUMINOUS CONCRETE BASE, BINDER, AND WEARING SURFACE LAYERS

424.01 Description

The work covered by this Section shall consist of a hot or warm bituminous plant mixed pavement layer placed on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, typical cross section, and placement rate shown on the plans or as directed by the Engineer.

The Contractor may use either hot mix or warm mix for all Superpave ESAL Range mixes in Section 424.

General requirements for all bituminous concrete pavements as specified in Section 410 are applicable to this Section, subject to any exceptions contained herein. Quality Control/Quality Assurance (QC/QA) requirements as specified in Section 106 are applicable to this section, subject to any exceptions contained herein.

The work will be accepted on a LOT by LOT basis in accordance with the applicable requirements.

424.02 Materials.

The materials furnished for use shall conform to the requirements of Section 410 and the following:

(a) Aggregates.

1. Procedure for acceptance of Coarse and Fine Aggregates.

All fine and coarse aggregate furnished shall come from an approved producer who is participating in and meeting the requirements of ALDOT-249, *Procedure for Acceptance of Coarse and Fine Aggregates*. The producer's name shall be listed in the Department's *Materials, Sources, and Devices with Special Acceptance Requirements Manual*, List I-1. The Department has established a list of qualified producers of fine and coarse aggregates. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

2. Types of acceptable Coarse Aggregates for Superpave.

Coarse aggregate shall be aggregate retained on the No. 4 {4.75 mm} sieve.

Coarse aggregate shall consist of crushed (or uncrushed) gravel with a bulk specific gravity greater than 2.550 (AASHTO T 85), crushed stone, or crushed slag, or a combination thereof having hard, strong, durable pieces, free from adherent coatings, and meeting all requirements of these specifications.

3. Flat and elongated particles in Coarse Aggregates for Superpave.

The maximum amount of flat and elongated particles in coarse aggregate for Superpave is given in the following table.

PERCENT OF FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE FOR SUPERPAVE	
Test Method	Maximum
Flat & Elongated % by Count 5:1 (max to min) ASTM D 4791 Section 8.4	10 % *
* Shall not apply to the 3/8 inch {9.5 mm} mix or to ESAL Range A/B	

4. Coarse Aggregate Soundness for Superpave.

The percent degradation of the source aggregate by the sodium sulfate soundness test (AASHTO T 104, Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate) after five cycles of testing shall not exceed 10 %.

5. Deleterious Materials and Absorption in Coarse Aggregate for Superpave.

The amount of deleterious substances and absorption in the coarse aggregate shall not exceed the following limits:

RESTRICTION OF DELETERIOUS MATERIALS AND ABSORPTION IN COARSE AGGREGATE FOR SUPERPAVE	
Coal and Lignite (Visual)	0.25 %
Clay Lumps and Friable Particles (AASHTO T 112)	0.25 %
Other local deleterious substances (Shale, Mica, Marcasite, etc.) (Visual)	2.0 %
Absorption (Absorption on the material passing the 3/4 inch {19.0 mm} sieve and retained on the No. 4 {4.75 mm sieve}) (AASHTO T 85 *). Applies to gravel aggregates only.	2.0 %
* Section 8.1 of AASHTO T 85 modified to require a 15 minute vacuum saturation period as per Section 6.3 of AASHTO T 209 prior to the required 15-19 hour soaking period.	

6. Los Angeles Abrasion Criteria for Coarse Aggregate for Superpave.

The percent loss of the coarse aggregate by the LA Abrasion test (AASHTO T 96, Resistance to Abrasion of Small Size Aggregate by use of the Los Angeles Machine) shall not exceed 48 % except that, for Sandstone and Blast Furnace Slag, the LA Abrasion shall not exceed 55 %.

7. Fine Aggregate for Superpave.

Fine aggregate shall be aggregate passing the No. 4 {4.75 mm} sieve. Gravel used to manufacture fine aggregate shall have a bulk specific gravity greater than 2.550 (AASHTO T 85).

The fine aggregate shall be non-plastic when tested in accordance with AASHTO T 89, as modified by ALDOT-232, and AASHTO T 90 and shall have a maximum of 1.0 % clay lumps and friable particles as determined by AASHTO T 112. It shall consist of hard, tough grain, free of injurious amounts of clay, loam, or other deleterious substances.

8. Clay Content for Superpave.

The amount of clay material, as indicated by the sand equivalent, measured on the aggregate passing the No. 4 {4.75 mm} sieve as determined by AASHTO T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test, shall be no less than the values defined in the following table according to the total design traffic in equivalent single axle loads (ESALs).

CLAY CONTENT CRITERIA FOR SUPERPAVE		
ESAL Range	Traffic (ESALs)	Sand Equivalent
A/B	ESALs $< 1.0 \times 10^6$	$\geq$ 40.0
C/D	$1.0 \times 10^6 \leq$ ESALs $< 1.0 \times 10^7$	$\geq$ 45.0
E	$1.0 \times 10^7 \leq$ ESALs $< 3.0 \times 10^7$	$\geq$ 45.0

9. Mineral Filler for Superpave.

Mineral filler shall consist of finely divided mineral matter such as rock dust, slag dust, hydrated lime, hydraulic cement, or fly ash meeting the requirements of Section 805.

The introduction of mineral filler shall be in accordance with AASHTO M 156, Section 3.3, as specified in ALDOT-324, with the additional requirement that accurate proportioning shall be accomplished by means of pneumatic or mechanical metering.

(b) Recycled Asphalt Pavement (RAP) & Reclaimed Asphalt Shingles (RAS).

The requirements for allowing the use of RAP and RAS are given in Article 410.02.

(c) Blend of Aggregates.

1. Gradations for blend of Aggregates.

The coarse and fine aggregates, mineral filler, and recycled material shall be combined in a total blend that will produce an acceptable job mix within the gradation limits determined by the maximum and minimum control points as shown in the following tables. Maximum particle size is defined as the sieve size that is two sizes larger than the first sieve to retain more than 10 % of the material. The sequence of sieve sizes to be used in determining maximum particle size is given in the following tables. Gradation charts illustrating gradation requirements are given in Article 424.03.

The required mix will be shown on the plans. All ALDOT-424 ESAL range "E" Wearing Surface Layer and Upper Binder Layer mixes shall be tested for susceptibility to rutting in accordance with the latest approved version of AASHTO T 324 Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures. All Mixes shall be tested at 50°C in water. ALDOT 424 ESAL Range E mixes using PG 67-22 binder shall exhibit 10 mm rutting or less at 10,000 cycles. ALDOT 424 ESAL Range E mixes using PG 76-22 binder shall exhibit 10 mm rutting or less at 20,000 cycles.

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 1 1/2 inch {37.5 mm} Maximum Aggregate Size Mix		
	Control Point (Percent Passing)	
Sieve Size	Minimum	Maximum
No. 200 {75 μm}	1	7
No. 8 {2.36 mm}	19	45
3/4" {19 mm}	19	90
1" {25 mm} Nominal	90	100
1.5" {37.5 mm} Maximum	100	-

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 1 inch {25.0 mm} Maximum Aggregate Size Mix		
	Control Point (Percent Passing)	
Sieve Size	Minimum	Maximum
No. 200 {75 μm}	2	8
No. 8 {2.36 mm}	23	49
1/2" {12.5 mm}	23	90
3/4" {19 mm} Nominal	90	100
1" {25 mm} Maximum	100	-

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 3/4 inch {19.0 mm} Maximum Aggregate Size Mix		
	Control Point (Percent Passing)	
Sieve Size	Minimum	Maximum
No. 200 {75 μm}	2	10
No. 8 {2.36 mm}	28	58
3/8" {9.5 mm}	28	90
1/2" {12.5 mm} Nominal	90	100
3/4" {19.0 mm} Maximum	100	-

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 1/2 inch {12.5 mm} Maximum Aggregate Size Mix		
	Control Point (Percent Passing)	
Sieve Size	Minimum	Maximum
No. 200 {75 μm}	2	10
No. 8 {2.36 mm}	32	67
No. 4 {4.75 mm}	32	90
3/8" {9.5 mm} Nominal	90	100
1/2" {12.5 mm} Maximum	100	-

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 3/8 inch {9.5 mm} Maximum Aggregate Size Mix		
	Control Point (Percent Passing)	
Sieve Size	Minimum	Maximum
No. 200 {75 μm}	6	12
No. 16 {1.18 mm}	30	60
No. 4 {4.75 mm} Nominal	75	100
3/8" {9.5 mm} Maximum	95	100
Note: Up to 5% may be retained on the maximum size sieve (3/8 inch {9.5 mm}) and up to 25% may be retained on the nominal size sieve (#4 {4.75 mm}).		

2. Coarse Aggregate Angularity for blend of Aggregates.

The coarse aggregate angularity shall be measured on the total blended aggregate retained on the No. 4 {4.75 mm} sieve in accordance with ASTM D 5821.

A fractured face is defined as an angular, rough, or broken surface of an aggregate particle created by crushing, by other artificial means, or by nature. A face is considered fractured only if it has a projected area at least as large as one-quarter of the maximum projected area (maximum cross-sectional area) of the particle and has sharp, well-defined edges.

The percent by weight {mass} of the coarse particles of the blended aggregate retained on the No. 4 {4.75 mm} sieve with one fractured face and with two or more fractured faces shall be no less than the values in the following table.

COARSE AGGREGATE ANGULARITY REQUIREMENTS FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Wearing Surface & Binder Layers	Base Layers
A/B	ESALs $< 1.0x10^6$	75 / -	50 / -
C/D	$1.0x10^6 \leq$ ESALs $< 1.0x10^7$	85 / 80	60 / -
E	$1.0x10^7 \leq$ ESALs $< 3.0x10^7$	95 / 90	80 / 75
Note: "85 / 80" denotes that 85 % of the coarse aggregate has at least one fractured face and 80 % has two or more fractured faces.			

3. Fine Aggregate Angularity for blend of Aggregates.

The percent air voids in loosely compacted fine aggregate, measured according to AASHTO T 304, Method "A", or ASTM C 1252, Method "A", *Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)* shall be no less than the values in the following table.

FINE AGGREGATE ANGULARITY REQUIREMENTS FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Minimum % Air Void	
		Base	Binder & Surface
A/B	ESALs $< 1.0x10^6$	43	43
C/D	$1.0x10^6 \leq$ ESALs $< 1.0x10^7$	43	45
E	$1.0x10^7 \leq$ ESALs $< 3.0x10^7$	43	45

4. Restrictions in the use of Carbonate Stone for blend of Aggregates.

The restrictions for the use of carbonate stone are given in the following table. These restrictions do not apply to widening as defined in Article 410. 01, shoulder paving, underlying layers, and layers that are to be covered by Polymer Modified Open Graded Friction Course (Section 420) mix in this contract.

CRITERIA FOR THE USE OF CARBONATE STONE IN SUPERPAVE	
BPN 9 Value Of Aggregate Source *	Maximum Allowable Percentage Of Carbonate Stone
≤ 25	30
26 through 28	35
29 through 31	40
32 through 34	45
≥ 35	50
* This value, BPN 9, is made using the British Pendulum Tester on aggregate source specimen polished for 9 hours on an accelerated polishing machine known as the British Wheel as per ASTM D 3319, ASTM E 303 and ALDOT-382.	

In no case shall the total amount of virgin carbonate stone in the combined mixture used as actual wearing surface layers that are exposed to traffic exceed the percentage shown in the above table. When parts of the carbonate stone used in the mix are from differing strata of material or coming from multiple sources that are represented by different BPN 9 values, the lowest BPN 9 value will be used.

(d) Liquid Asphalt Binder.

Liquid asphalt binders shall come from an approved producer who is participating in and meeting the requirements of ALDOT-243, *Acceptance Program For Asphalt Materials*. The producer's name shall be listed in the Department's *Materials, Sources, and Devices With Special Acceptance Requirements* Manual, List I-4. The Department has established a list of qualified producers of asphalt materials. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list. Unless shown otherwise on the plans or in the proposal, liquid asphalt binder for use in all mixes shall meet the requirements of AASHTO M

320, *Standard Specification For Performance Graded Asphalt Binder,* as modified by the requirements given in the following table and Section 804.

ALLOWABLE ASPHALT BINDER GRADES FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Base, Lower, & Upper Binder Layers	Wearing Surface Layers
A/B	ESALs < $1.0x10^6$	PG 67-22	PG 67-22
C/D	$1.0x10^6 \leq$ ESALs < $1.0x10^7$	PG 67-22	PG 67-22
E	$1.0x10^7 \leq$ ESALs < $3.0x10^7$	PG 67-22	PG 76-22*
*The asphalt binder shall be PG 76-22 for leveling when the top of the leveling is within 2 inches {50 mm} of the final pavement surface. The asphalt binder may be PG 67-22 for leveling that is not within 2 inches {50 mm} of the final pavement surface and for all patching and widening;. If Open Graded Friction Course (Section 420) layers are required, the final pavement surface shall be the surface of the layer below these layers.			

Asphalt Binders shall meet the requirements of Section 804.

Polymer modifiers shall be blended at an approved refinery and meet the requirements of Section 811. Approved Warm Mix additives or processes are given in List II-27, "Warm Mix Asphalt Products and Processes" of the Materials, Sources, and Devices with Special Acceptance Requirements manual.

(e) Mix Properties.

1. Air Voids (Va).

The design air voids for all levels of traffic is 3.5 % for mixes containing RAS and 4.0 **% for all other mixes**.

2. Voids in Mineral Aggregate (VMA).

The job mix shall be designed at a minimum VMA given in the following table.

VOIDS IN MINERAL AGGREGATE DESIGN VMA FOR SUPERPAVE ***		
Maximum Aggregate Size * (inches) {mm}	Nominal Aggregate Size (inches) {mm}	Minimum VMA (%)
3/8 {9.5 }	No. 4 {4.75}	16.5 **
1/2 {12.5 }	3/8 {9.5}	15.5
3/4 {19.0 }	1/2 {12.5}	14.5
1 {25.0 }	3/4 {19.0}	13.5
1.5 {37.5 }	1 {25.0}	12.5
* As defined in Subarticle 424.02(c) ** All 3/8" (9.5 mm} mixes where the ESAL range is greater than A/B shall have a maximum VMA of 18.0. *** Production VMA may be 0.5 lower than the Minimum VMA given above.		

3. Liquid Asphalt Binder Content (Pb).

The job mix shall be designed at a minimum Liquid Asphalt Binder Content (Pb) given in the following table. Production tolerances shall be governed by the pay factors in Table III, Section 410.08.

LIQUID ASPHALT BINDER CONTENT (Pb) CRITERIA FOR SUPERPAVE			
Maximum Aggregate Size* (inches) {mm}	Nominal Aggregate Size (inches) {mm}	Minimum Liquid Asphalt Binder Content (Pb) by Percent of Total Mix**	Minimum Liquid Asphalt Binder Content (Pb) for mixes containing RAS by Percent of Total Mix**
3/8 {9.5 }	No. 4 {4.75}	5.90	6.1
1/2 {12.5 }	3/8 {9.5}	5.50	5.7
3/4 {19.0 }	1/2 {12.5}	5.10	5.3
1 {25.0 }	3/4 {19.0}	4.40	4.6
1.5 {37.5 }	1 {25.0}	4.20	4.4
* As defined in Subarticle 424.02(d) ** Nd = 60			

4. Dust Proportion (D/Pbe).

The ratio of the percent by weight {mass} of aggregate passing the No. 200 {75 µm} sieve to the effective asphalt content expressed as percent by weight {mass} of the total mix shall be between 0.60 and 1.4. All 3/8 inch {9.5 mm} mixes shall have a dust to effective asphalt ratio range of 0.90 to 2.00. These ratio limits apply to both the design and production phases. Effective asphalt content is that liquid asphalt binder not absorbed into the aggregate pore structure and is determined in accordance with Section 4.09 of the Asphalt Institute's, MS-2, *Mix Design Methods for Asphalt Concrete*.

5. Liquid Asphalt Binder Draindown.

A fiber stabilizer meeting the requirements given in Section 410 may be incorporated into the mix to reduce draindown. The fiber shall be blended into the mix in accordance with the requirements given in Section 410.

6. Resistance to Moisture-Induced Damage.

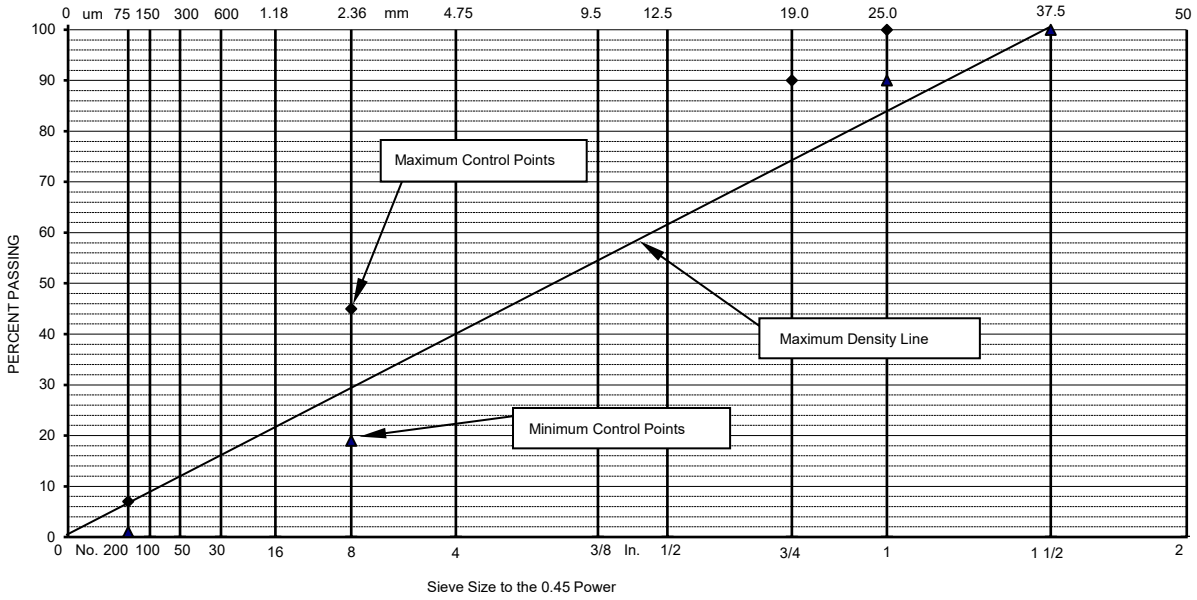
All mixes shall be designed and produced to have a tensile strength ratio (TSR) of at least 0.80 when compacted according to ALDOT-384 at 7.0 % air voids and tested in accordance with AASHTO T 283 as modified by ALDOT-361, except the specimen shall be 6.00" {150 mm} in diameter and 3.75" {95 mm} in height.

(f) Design Procedure.

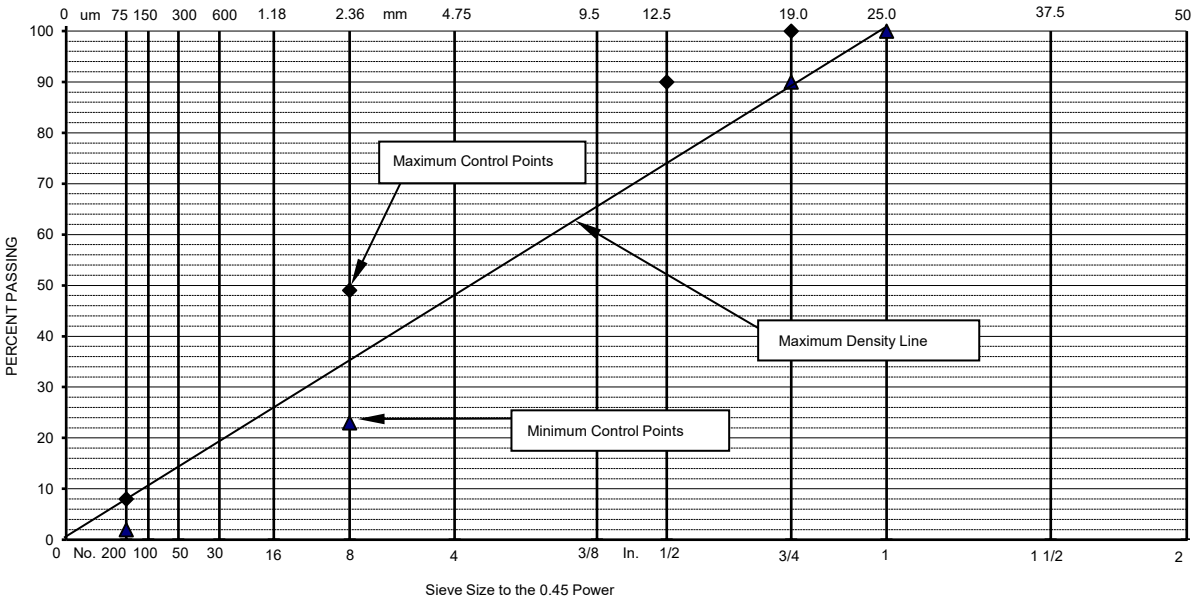
All Superpave mixes shall be designed in accordance with ALDOT-384, *Superpave Mix Design Procedure for Asphalt Mixtures*. All Superpave Gyratory Compactors shall have their angle of gyration verified by the Engineer following the procedure in AASHTO T 344, Standard Method of Test for Evaluation of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading. This includes all design, quality control, and quality assurance SGCs. The compactors shall tilt the specimen molds at an average internal angle of 20.2 ± 0.35 mrad (1.16± 0.02 degrees).

424.03 Gradation Requirements.

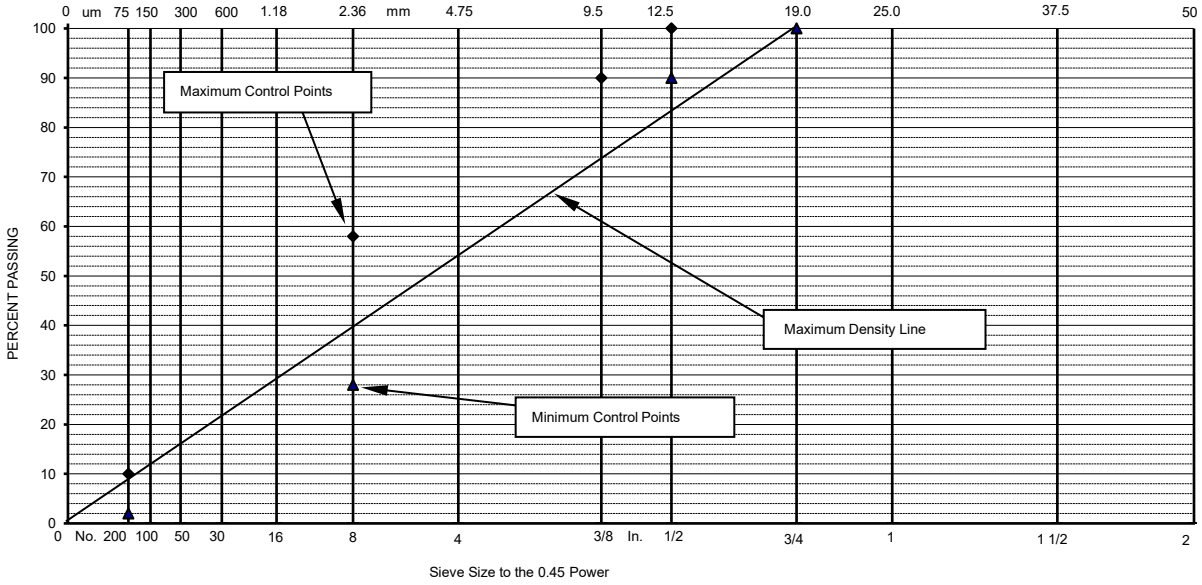
GRADATION CHART FOR 1 1/2 inch {37.5 mm} MAXIMUM SIZE AGGREGATE



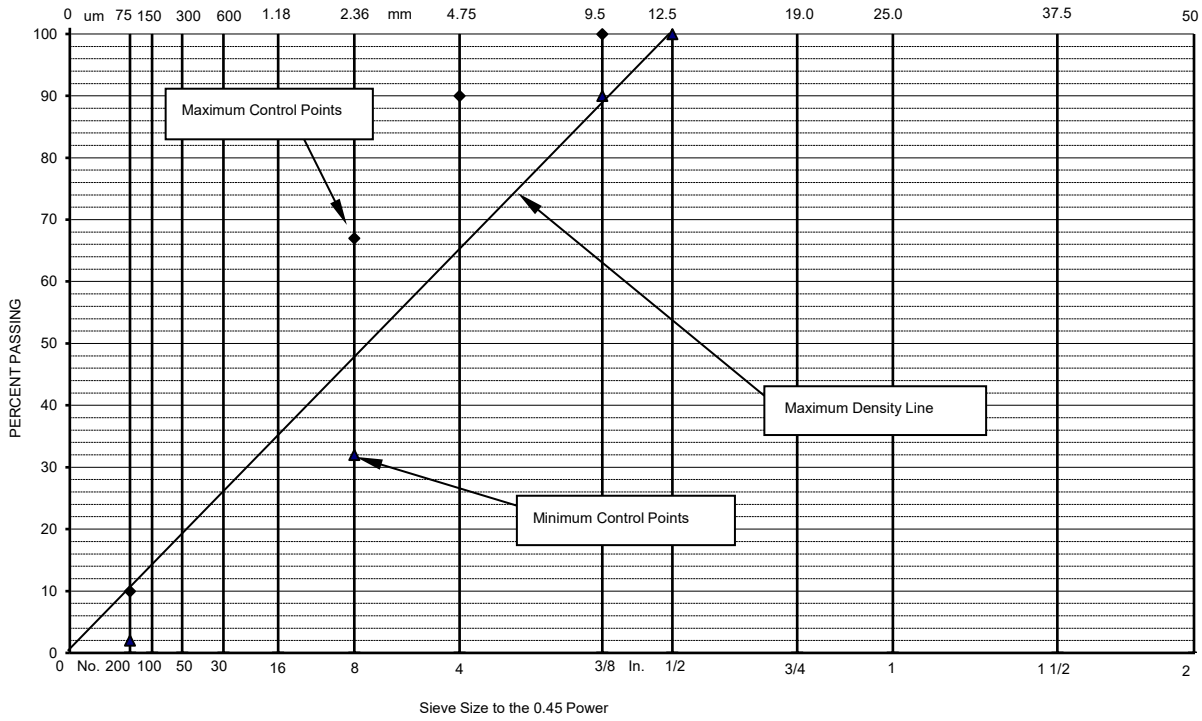
GRADATION CHART FOR 1 inch {25 mm} MAXIMUM SIZE AGGREGATE

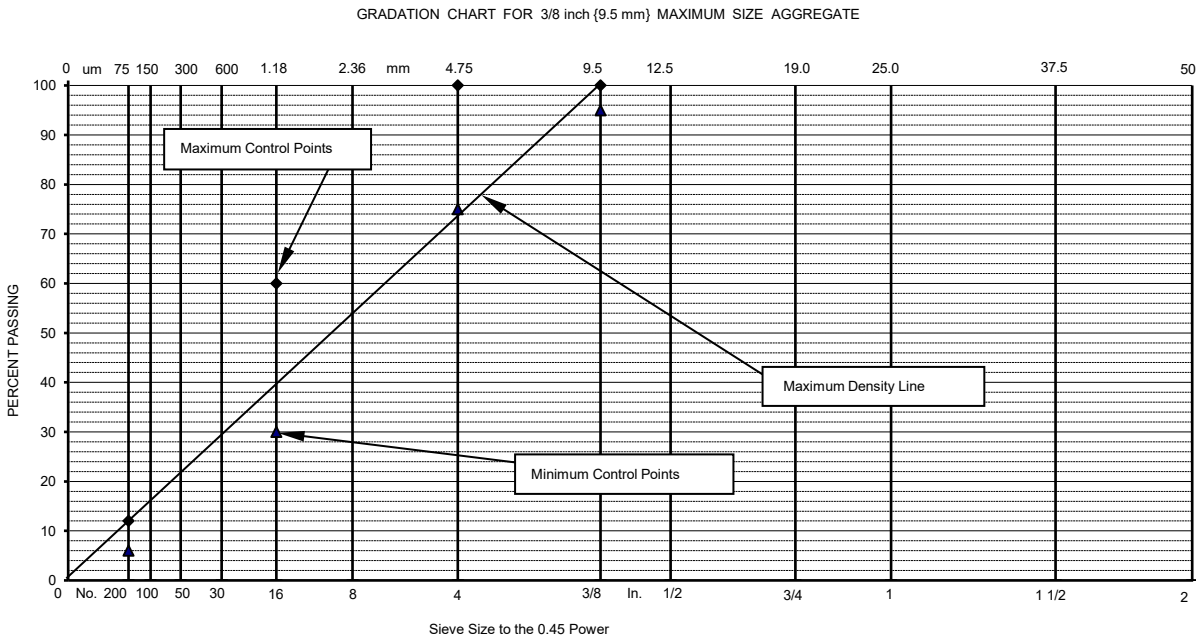


GRADATION CHART FOR 3/4 inch {19 mm} MAXIMUM SIZE AGGREGATE



GRADATION CHART FOR 1/2 inch {12.5 mm} MAXIMUM SIZE AGGREGATE





424.04 Construction Requirements.

(a) General.

The mixing temperature of the asphalt mixture shall not exceed 350 °F {177 °C}.

(b) Binder Layer and Wearing Surface Layer.

Construction requirements shall be as specified in Articles 410.03 through 410.07.

(c) Base Layer.

The construction requirements for base layers shall be as specified in Articles 410.03 through 410.07, except as follows:

The edges shall be trimmed immediately after final rolling, using an accurately aligned string or wire, to a tolerance of 2 inches {50 mm} outside the theoretical edge of the layer and to a slope not flatter than 1:1.

Any edge distorted by rolling shall be promptly corrected.

(d) Preparation of Mixtures - Moisture Content.

Each time an asphalt content measurement is made (ALDOT-354 or AASHTO T 308), the amount of moisture in the mixture shall be determined, regardless of aggregate type, as specified in ALDOT-130 and reported on Form BMT-20. The moisture determination shall be used in computing the corrected asphalt content. Moisture samples shall be taken with the asphalt content samples from the loaded truck. Moisture in the mixture shall not exceed 0.20% by weight {mass}.

(e) Production Tolerances.

All mixtures furnished for use shall conform to the approved job mix formula (JMF) within the tolerances set in Article 410.02. Mixture gradations may be produced provided the gradations are within the tolerances.

424.05 Method of Measurement.

The accepted quantities of Superpave Bituminous Concrete Wearing Surface Layer, Superpave Bituminous Concrete Binder Layer, and Superpave Bituminous Concrete Base Layer will be measured as provided in Article 410.08, subject to any exceptions contained herein.

424.06 Basis of Payment.

(a) Unit Price Coverage.

Superpave Bituminous Concrete Wearing Surface Layer, Superpave Bituminous Concrete Binder Layer, and Superpave Bituminous Concrete Base Layer will be paid for at the contract unit price bid in accordance with Article 410.09, subject to any exceptions contained herein.

(b) Payment will be made under Item No.:

424-A Superpave Bituminous Concrete Wearing Surface Layer, ___** , ___*** Maximum Aggregate Size Mix, ESAL Range ____**** - per ton {metric ton}

424-B Superpave Bituminous Concrete ___* Binder Layer, ___** , ___*** Maximum Aggregate Size Mix, ESAL Range ____**** - per ton {metric ton}

424-C Superpave Bituminous Concrete Base Layer, ___** , ___*** Maximum Aggregate Size Mix, ESAL Range ____**** - per ton {metric ton}

* Specify either “Upper” or “Lower”.

** Specify "Patching", "Leveling", "Widening", etc. only when required.

*** Specify Maximum Aggregate Size: 3/8", 1/2", 3/4", 1", or 1.5" {9.5 mm, 12.5 mm, 19.0 mm, 25.0 mm, or 37.5 mm}.

**** Specify “A/B”, “C/D”, or “E”.

SECTION 428
SCORING BITUMINOUS PAVEMENT SURFACE

428.01 Description.

This Section shall cover the work of scoring bituminous plant mix pavement surfaces at locations shown on the plans or directed by the Engineer. The scoring shall consist of cutting grooves, at regular intervals in the shoulder pavement surface.

428.02 Materials.

N/A

428.03 Construction Requirements.

(a) General.

It is intended that areas of the pavement surface designated by the plans or by the Engineer to be scored shall be so done as to produce a rumble strip effect to alert inattentive drivers.

The size, shape, and spacing of the grooves formed during the cutting procedure shall be as shown on the plans unless a different configuration is approved by the Construction Engineer. Unless ordered otherwise by the Engineer, all grooves shall be perpendicular to the pavement edge.

(b) Equipment.

The scoring equipment shall consist of a rotary type cutting head with cutting tips arranged in a pattern that will provide a smooth cut. The cutting head shall be on its own independent suspension from that of the power unit to allow the tool to align with the slope of the shoulder and any irregularities in the shoulder surface.

(c) Operational Requirements.

The equipment shall be operated in a workmanlike manner that will satisfactorily produce a pavement surface having uniform grooves of the dimensions and spacing as shown on the plans or specified in this Article.

Equipment used to construct scored shoulders shall be positioned by using methods which will avoid scoring at locations other than those designated on the plans or directed by the Engineer.

The debris that results from cutting shall be removed on a daily basis by a sweeper/vacuum or other approved methods.

428.04 Method of Measurement.

The scoring of bituminous pavement surface ordered and accepted will be measured per mile {kilometer} along the centerline of each row of grooves placed either by direct measurement and computation to the nearest 0.001 mile {0.001 kilometer} or by odometer to the nearest 0.001 mile {0.001 kilometer}. When more than one row of grooves is required on a surface, each row will be measured separately. The length of scoring measured will include any gaps shown on the plans as part of the design of the scoring but will not include the length of any other gap or section omitted by the Engineer.

428.05 Basis of Payment.

(a) Unit Price Coverage.

The scoring of bituminous pavement surface, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the scoring of the pavement, and for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

428-A Scoring Bituminous Pavement Surface – per mile {kilometer}

SECTION 430
SOIL OR AGGREGATE TYPE SURFACE

430.01 Description.

The work under this Section shall consist of constructing a temporary or permanent surface course of soil type material (Selected Material, Granular Soil or Soil Aggregate, etc.) or graded aggregate type material.

The plans or proposal will designate the type of material to be used.

430.02 Material.

All material furnished for use shall meet the appropriate requirements of Division 800, Materials, for the classification of material specified by the pay item.

430.03 Construction Requirements.

(a) Equipment.

Selection of the appropriate type of equipment to satisfactorily accomplish the work will, in general, be at the option of the Contractor.

(b) Preparation of Underlying Surface.

Before placing the surface material, the subgrade shall comply with the requirements of Subarticle 301.03(a).

If the soil or aggregate surfacing is to be used in a temporary manner for handling traffic, the requirements for underlying surface preparation may be modified as shown on the plans, or directed by the Engineer, and control elevation stakes will not be necessary.

If the soil or aggregate surfacing is used for shoulder construction adjacent to the resurfacing of the roadway, the requirements given in Subarticle 301.03(a) will not be applicable and the underlying surface shall be compacted as directed by the Engineer.

(c) Placing, Spreading and Shaping.

Local type materials (Selected Material, Granular Soil, and Soil Aggregate) shall be yard mixed as described in Item 301.03(c)3 before being hauled to the roadbed.

Approved surfacing material may be dumped directly on the prepared subsurface and the material spread to the width and depth shown on the plans or directed.

Water shall be added if so directed.

Mixing will not be required unless so specified on the plans. If mixing is specified, it shall be performed in accordance with the requirements of Item 301.03(c)2.

Upon completion of the spreading, the material shall be shaped to the cross section shown on the plans and rolled to a smooth riding surface, free from high spots or depressions and satisfactory to the Engineer. Specific density requirements are waived; however, it shall be compacted to the satisfaction of the Engineer.

After being placed and shaped to proper crown and grade the surface shall be shaped at frequent intervals as directed and shall be kept free of ruts and holes. New material shall be added and bladed as needed and as directed. The surface shall be maintained in satisfactory condition in the manner described above until the contract is accepted.

430.04 Method of Measurement.

The quantity of surfacing material placed on the roadbed will be measured in cubic yards {cubic meters} in accordance with the provisions of Subarticle 109.01(i), or per ton {metric ton} measured by weight {mass} in accordance with the provisions of Subarticle 109.01(h).

430.05 Basis of Payment.

(a) Unit Price Coverage.

Surfacing material ordered and accepted, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the material complete in place on the roadbed and includes all costs incident to furnishing and producing the material, all hauling, spreading, mixing, watering, compacting, shaping, and for all equipment, tools, labor, and incidentals necessary to complete the work. Additional material used in the maintenance will be measured and paid for under this item.

(b) Payment will be made under Item No.:

430-A Soil Type Surfacing(Kind Material) - per cubic yard {cubic meter}
430-B Aggregate Surfacing(ALDOT Size of Material) - per ton {metric ton}

SECTION 433
SCRUB SEAL

433.01 Description.

This Section covers the placement of a polymer modified asphalt rejuvenating scrub seal.

433.02 Materials.

All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(a) Emulsion.

Sources for scrub seal shall meet the requirements given in Article 804.01.

The emulsion shall be a CMS-1PC for rejuvenating scrub seal meeting the requirements in Table 1.

Table 1

Property	Method	Specification
		CMS-1PC
Test on Emulsion		
Viscosity @ 77°F (SFS)	AASHTO T 59	50-350
Residue, w%, minimum	AASHTO T 59	60
pH	ASTM E70	2.0-5.0
Sieve, w%, max.	AASHTO T 59	0.1
Oil distillate, w%, max.	AASHTO T 59	0.5
Test on Residue(1)		
Penetration @ 39.2°F, 200 g, 60 sec., minimum	AASHTO T 49	30
MSCR, 52°C, Jnr, 3.2/kPa, max.	AASHTO T 350	4.0
MSCR, 52°C, % Recovery, 0.1/kPa, minimum	AASHTO T 350	30
Test on Polymer:		
Tensile strength, die C dumbbell, psi, minimum	ASTM D412 (2)	800
Swelling in rejuvenating agent, % maximum; 48 hours exposure @ 104°F	ASTM D471(3) Modified	40%
Test on Rejuvenating Agent:		
Flash point, COC, °F	AASHTO T 48	380 Min
Viscosity, 140°F, CST	AASHTO T 201	15-175
Saturate, % by wt.	ASTM D2007	30 Max
Asphaltenes	ASTM D2007	1.0 Max.
Test on Residue from RTFO		
Weight Change, %	AASHTO T 240	6.5 Max.
Viscosity Ratio	AASHTO T 201	3 Max

(1) Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350° F plus or minus 10° F. Maintain at this temperature for 20 minutes. Complete total distillation in 60 plus or minus 5 minutes from first application of heat.

(2) Tensile Strength Determination: Samples for testing for tensile strength in accordance with ASTM D412 shall be tested with the following test procedure modifications:

Prepare the polymer film, dilute the waterborne polymer to 40% Total Solids Content and pour 57 g into a Teflon or silicone release mold of dimensions 7'' X 7'' X ¼''. Allow to dry at 23°C (73 °F) and 50% RH (controlled conditions) for 7 – 10 days total time, during which time the film should be flipped around once, preferably after 3 or 4 days. The film should be transparent in the end. To drive out any residual water, place the film in an oven at 50°C for 30 min. Dried film thickness should be 25 mil +/- 5 mils. Discard films <20 mil. Cut out dumbbell-shaped test specimens of dimension 75 mm total length, 25 mm mid-section (L) and 4 mm width of mid-section. Grip in Instron machine with gap size 1 inch, use 8 inch/min cross-head speed.

(3) Polymer testing shall be prepared from polymer as follows:

Resistance to Swelling: Using a syringe, place 0.8 gm of latex into an 18 mm diameter DSR mold. Allow the sample to dry at ambient lab conditions (air conditioned) on the bench for 72 hours. Sample should be easily removable from the mold. Take the "button" out of the mold and place the sample into a forced air oven at 40°C (104°F) for 48 hours (on release paper). If at the end of the ambient dry, the sample sticks to the mold, place it into the oven and check it after 1-2 hours. After 48 hours cool and weigh the sample to the nearest 0.0001 gram and record the weight. Put ½ inch of Rejuvenating Agent into a 3 oz penetration tin. Place the "button" on the Rejuvenating Agent, and add another ½ inch of Rejuvenating Agent, so that the "button" is covered. Put the cap on the penetration tin and place it into the 40°C oven for 48 hours. . Remove the "button from the Rejuvenating Agent, blot surface of the "button" to remove excess Rejuvenating Agent, cool the "button" to room temperature and weigh it. Calculate weight gain of the "button", express as a percent.

The emulsion manufacturer shall submit certification that the emulsion meets the specification. The polymer manufacturer, through the emulsion supplier and the contractor, shall submit to the Department test results from an approved laboratory and certification that the polymer is cationic and meets the required specifications. The manufacturer of the recycling agent, through the emulsion supplier and the contractor, shall submit the test results on the recycling agent and certification that the recycling agent meets the required specifications. Polymer films required for testing shall be prepared by the same laboratory testing the polymer performance requirements as outlined in the specification. The manufacturer of the recycling agent shall submit to the laboratory testing the polymer a one-quart sample of the recycling agent for use in the swell test.

For the polymer, certification shall be from a laboratory with an ISO 17025 certification and accredited by IAS. Laboratories must be accredited in the test procedures specified above for the polymer and the rejuvenating agent. Certifications and test results on the emulsion, the polymer and the recycling agent shall be submitted to the Materials and Tests Engineer and approved prior to starting the work.

(b) Aggregate.

The aggregate shall be an ALDOT Size No. 89 or No. 89 Modified in accordance with the material requirements for bituminous surface treatments given in Section 801 and the modified No. 89 gradation below:

Sieve	% Passing
½"	100
⅜"	90-100
#4	20-55
#8	0-15
#16	0-10
#50	0-5

433.03 Construction Requirements.

(a) Placement Rates and Temperature.

The placement rate for the emulsion shall be from 0.25 to 0.35 gallons per square yard. The Engineer will require that the placement rate be adjusted up or down as necessary to fill the cracks in the roadway.

The placement rate for the aggregate shall be from 18 to 25 pounds per square yard. The Engineer will require that the placement rate be adjusted so that no bleed through occurs during rolling.

(b) Weather.

The scrub seal shall only be applied when the air temperature is above 45 °F with the forecast high temperature being less than 100 °F.

The application of the scrub seal shall be stopped a minimum 24 hours prior to expected rain.

(c) Surface Preparation.

The area to be covered shall be cleaned of dirt, vegetation, and dust and other deleterious materials prior to the application of the surfacing.

On pavements where the scrub seal is to be the final layer, the Contractor should remove all existing thermoplastic striping, markings, and legends within the scrub seal limits prior to the scrub seal operation. If a subsequent surface treatment or pavement layer will be placed over the scrub seal, removal of the existing thermoplastic may not be required.

Prior to the scrub seal operation, the Contractor shall remove all raised pavement markers including any excessive adhesive left on the pavement caused from the removal of raised pavement markers.

Prior to the scrub seal operation, all drain inlet covers, monument covers, and all other utility covers shall be protected from the Contractor's scrub seal operations by applying a sheet of plastic over the exposed facilities, or other methods approved by the Engineer.

(d) Test Section.

The Contractor shall demonstrate the capability of meeting the placement requirements. The materials used in the test section shall be those that are proposed for production use. The Engineer will identify the location and length of the test section. The test section shall be one lane, 12 feet in width and up 1000 feet long. The Contractor shall verify in the presence of the Engineer the asphalt distributor's and aggregate spreader's calibrated application rates. If the application to the test section is unsuccessful, the Contractor shall make the necessary corrections and apply a new test section without additional compensation.

The placement rate and adhesion of the emulsion and aggregate will be evaluated.

(e) Equipment.

1. Asphalt Distributor.

An asphalt distributor shall be furnished for the application of the asphalt emulsion. The distributor shall have a full circulating spray bar that is adjustable to at least 16 feet wide in two feet increments and is capable of heating and circulating the emulsion simultaneously. It shall have computerized rate control for adjusting and controlling the application from the cab. The rate shall be is adjustable by .01 gallons per square yard increments. The distributor shall also be equipped with a volume measuring device and a thermometer for measuring the emulsion temperature in the tank.

2. Emulsion Broom.

The emulsion broom frame shall be constructed of metal. The emulsion broom shall be attached to and pulled by the distributor truck. The emulsion broom must be equipped with a means of raising and lowering the emulsion broom at desired points. It shall be towable in the elevated position. The broom assembly shall be such that it does not squeegee the emulsion off the roadway surface.

The main body of the emulsion broom shall have a minimum frame size of 6.5 feet wide and 10 feet long. The maximum transverse rigid frame width at any point shall not exceed 6.75 feet. The nearest and furthest members, paralleling the back of the spreader truck, and diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have brooms heads angled at 10 to 15 degrees off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the emulsion broom assembly shall be 3.5 inches wide x 6.5 inches high x 16 inches long and have stiff nylon bristles. Bristle height is to be maintained at a minimum of five inches (5"). The emulsion broom shall be equipped with hinged wing assemblies attached to the main

body not to exceed 4.5 feet per side, with diagonals and equipped with street brooms. The purpose of the maximum rigid frame width and the hinged wing extensions is not only for maximum width of 16 feet but to maintain the scrubbing process evenly as contours and cross-sections change across the existing road surface.

3. Aggregate Spreader.

A self-propelled spreader with computerized rate control shall be used to spread the aggregate. The spreader shall have front discharge and shall be capable of evenly distributing the aggregate at the required placement rates.

4. Rollers.

Two pneumatic tire rollers shall be used to seat the aggregate into the emulsion. The rollers shall be self-propelled. The minimum total weight of each roller shall be 5 tons.

5. Aggregate Removal Equipment.

A mechanically powered pick-broom shall be furnished with a vacuum for the removal of excess aggregate.

(f) Material Application.

The emulsion broom shall be pulled behind the emulsion distributor immediately after the application of the emulsion. All cracks in the pavement shall be filled by emulsion by the movement of the weighted emulsion broom through the emulsion.

The aggregate shall be dry during spreading. The aggregate shall be evenly spread over the scrubbed emulsion.

The seal should be rolled immediately after the aggregate is applied. There shall be at least three passes made with a pneumatic roller.

The scrub seal system shall be stiff enough to allow sweeping up excess aggregate without damage to the pavement surface. The excess aggregate shall be removed with the vacuum broom within two hours of rolling or as directed by the Engineer.

The roadway shall not be opened to traffic until at least two hours after the completion of the placement of the emulsion and aggregate. The Engineer may require a second power sweeping to remove any loose aggregate. Excess aggregate shall be removed from the project unless otherwise approved by the Engineer.

For inner layer applications the scrub seal shall be sufficiently cured prior to placing a bituminous overlay, micro-surfacing, or other asphalt surface treatments. The Engineer will require a second power sweeping of the scrub seal surface at least two hours after completion of the placement of the emulsion and aggregate to determine the status of the scrub seal being cured. The ability to sweep all loose aggregate from the surface without removing any aggregate adhered to the bituminous emulsion shall determine that the scrub seal is cured.

Longitudinal joints shall not overlap. The longitudinal construction joint shall coincide with the painted lane line or at the outside edge of shoulder.

(g) Sampling.

A minimum of one daily sample of the aggregate will be taken from the application vehicle and tested for gradation. If the average test results vary from the gradation requirements, production shall stop. The Contractor shall identify the cause and document in detail what corrective action was taken. Documentation of the corrective action shall be furnished to the Engineer before placement will be allowed.

(h) Acceptance.

The Contractor shall be responsible for the maintenance of the surface treatment until the work is accepted by the Engineer. Damage or loss of aggregate in the surface exceeding 2 % of the surface area in any 500-foot-long section shall be repaired by use of additional emulsion and aggregate. All bleeding (excess asphalt) surfaces shall be covered with additional concrete sand in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

If in the Engineer's judgment, defective areas warrant removal, the Contractor shall remove and replace those areas at the Contractor's expense with materials meeting specification requirements.

433.04 Method of Measurement.

Scrub seal will be measured in units of square yards.

433.05 Basis of Payment.

(a) Unit Price Coverage.

The unit price of the scrub seal shall be full compensation for all materials, equipment, tools, and labor required for furnishing and placing the scrub seal, for removing and disposing of raised pavement markers, and for post-sweeping. If removal of thermoplastic striping, markings, or legends is required, it will be paid for under Item 701D or Item 703C.

(b) Payment will be made under Item No.:

433-A Scrub Seal - per square yard

SECTION 450
PORTLAND CEMENT CONCRETE PAVEMENT

450.01 Description.

The work covered by this Section consists of constructing a pavement of Portland Cement Concrete.

450.02 Materials.

(a) References for Material Requirements.

All materials shall conform to the requirements given in Division 800, Materials.

The requirements given in the following Sections are directly applicable to the materials furnished for the concrete pavement:

- Section 801 Coarse Aggregate
- Section 802 Fine Aggregates
- Section 804 Bituminous Materials
- Section 806 Mineral Admixtures
- Section 807 Water
- Section 808 Air Entraining Additives
- Section 809 Chemical Admixtures for Concrete
- Section 815 Cement
- Section 830 Concrete Curing Material
- Section 832 Concrete Joint Fillers, Sealers, and Waterstop Material
- Section 835 Steel Reinforcement

(b) Aggregates.

1. Fine Aggregate.

Fine aggregate shall be ALDOT Size No. 100 Concrete Sand meeting the requirements of Section 802. Sand shall be natural sand except that it may include 20 percent crushed quartzite particles. A blend of two natural sands will be permitted if a written request is submitted to the Materials and Tests Engineer for approval.

2. Coarse Aggregate.

a. Gradation.

Each component size shall be stockpiled separately at the batching plant.

b. Type of Coarse Aggregate.

Coarse aggregate shall be granite, sandstone, quartzite, or gravel with a specific gravity greater than 2.550 (specific gravity requirement applies to gravel only). Gravel with a specific gravity less than or equal to 2.550 will not be allowed.

Aggregates that tend to polish under traffic, such as limestone, dolomite, or marble, shall be permitted as noted in the following table.

ALLOWABLE CARBONATE STONE CRITERIA	
BPN 9 Value of Aggregate Source *	Maximum Allowable Percentage of Carbonate Stone
≤ 20	Not Allowed
21 through 25	30
26 through 28	35
29 through 31	40
32 through 34	45
≥ 35	50
* This value, BPN 9, is made using the British Pendulum Tester on aggregate source specimen polished for 9 hours on an accelerated polishing machine known as the British Wheel as per ASTM D 3319, ASTM E 303 and ALDOT-382.	

If limestone, dolomite, or marble are used as coarse aggregate in the percentages allowed in the table above the remainder of the coarse aggregate blend shall be granite, sandstone, quartzite, or gravel with a specific gravity greater than 2.550 (specific gravity requirement applies to gravel only). Gravel with a specific gravity less than or equal to 2.550 will not be allowed.

When parts of the carbonate stone used in the mix are from differing strata of material or coming from multiple sources that are represented by different BPN 9 values, the lowest BPN 9 value will be used.

If the Contractor requests to use a percentage of carbonate stone in excess of the value of the above table or for the total amount of carbonate stone to be greater than 50 percent, grinding as defined in Item 450.04(b)2 will not be permitted.

c. Los Angeles Abrasion Criteria for Carbonate Stone.

When carbonate stone is used in the concrete mixture design, the percent loss of the coarse aggregate by the LA Abrasion test (AASHTO T 96, Resistance to Abrasion of Small Size Aggregate by use of the Los Angeles Machine) shall not exceed 40%.

d. Micro-Deval Abrasion Criteria for Carbonate Stone.

When carbonate stone is used in the concrete mixture design, the percent loss of the coarse aggregate by the Micro-Deval test (AASHTO T 327, Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus) shall not exceed 18%.

3. Combined Aggregate Gradation.

The Contractor shall use Combined Grading Analysis to produce a well-graded aggregate in designing the concrete mixture. The Contractor shall submit the following data with any concrete mixture design:

- Gradations for all coarse and fine aggregates.
- Coarseness Factor Chart.
- 0.45 Power Chart.
- Chart showing the percent of combined aggregate retained on each sieve.

4. Crushed Concrete Used as Aggregate.

Crushed concrete may be used as an aggregate if this is shown to be allowed on the plans. The crushed concrete used as an aggregate shall meet the requirements given in this Section and the requirements given in Articles 801.01, 801.02, and 801.03.

(c) Portland Cement.

The concrete producer may use Type I, Type II or Type IL cement. The concrete producer may substitute Type III Portland cement, provided prior approval is given by the Materials and Tests Engineer and it is included in the proposed mix design.

(d) Admixtures.

1. Chemical Admixture.

Any chemical admixture used in the concrete mixture shall be included in the mixture design proposal. Only approved chemical admixtures listed in List II-1, “Chemical Admixtures for Portland Cement Concrete”, of the MSDSAR manual shall be used in Department concrete mixes. The dosage of chemical admixtures may be adjusted in the field to obtain the desired results, provided that the manufacturer’s recommended dosage is not exceeded.

2. Mineral Admixture.

Mineral admixtures may be used in any concrete pavement mixture design except where it is specified otherwise by the plans and proposal. Substitution percentages are calculated by weight.

The maximum substitution of cement with mineral admixtures shall not exceed 50 percent. The following table shows the maximum substitution of cement with any one mineral admixture.

MAXIMUM PERCENT MINERAL ADMIXTURE SUBSTITUTION FOR CEMENT (substitution by weight)	
MINERAL ADMIXTURE	PERCENTAGE SUBSTITUTION
Class C or Class F Fly Ash	30 %
Ground Granulated Blast Furnace Slag	50 %
Microsilica	10 %

(e) Concrete Mix Design.

1. Submittal of Mix Design.

The Contractor's concrete producer shall establish the proportion of materials following the guidelines described in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete". It shall be the responsibility of the concrete producer to request approval of concrete mixture design(s) for use in Department's projects. The Contractor shall submit the proposed concrete mixture no later than 65 Calendar Days after the date of Notice to Proceed. The Department shall be allowed 28 Calendar Days to complete the review and approval of the concrete mixture.

2. Mix Design Criteria.

The concrete producer shall submit a mix design meeting the following parameters:

- Maximum water to cementitious material ratio of 0.45.
- Maximum slump of 2.0 inches {50 millimeters} when a slip form paver, as defined in Subarticle 450.03(f), is used.
- Maximum slump of 3.5 inches {90 millimeters} when fixed forms, as defined in Subarticle 450.03(e), are used. Approved Type "F" chemical admixtures may be used to chemically increase the slump of the concrete to 6.0 inches {150 mm}.
- Total entrained air percentage by volume between 2.5% and 6.0%.
- Minimum flexural strength of 650 psi at 28 days.
- Minimum compressive strength determined by correlation with the minimum allowable flexural strength. The compressive strength shall not be less than 4,000 psi at 28 days.

For concrete mixtures using portland cement only, the concrete producer shall submit data showing that the total alkali contribution from the cement in the concrete does not exceed 4.00 lb/Yd^3 when calculated as follows:

$$lb\ of\ alkali\ per\ Yd^3 = \frac{(lb\ of\ cement\ per\ Yd^3) \times (\%\ Na_2O\ equivalent\ in\ cement)}{100}$$

3. Correlation of Compressive Strength with Flexural Strength.

In addition to the requirements listed in Item 5 of ALDOT-170, the concrete producer shall submit a correlation of the flexural strength versus the compressive strength. This submittal shall be made at the same time as the submittal of the proposed mix design.

A correlation of the flexural strength versus the compressive strength for 7 and 28 day strengths shall be made and shall be based on at least 3 tests for each age from the proposed concrete mixture. The minimum 28-day flexural strength shall be 650 psi. The flexural strength shall be obtained from beam specimens made in accordance with ASTM C 192, "Making and Curing Concrete Test Specimens in the Laboratory" and tested in accordance with the requirements given in AASHTO T 97, "Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)". The minimum allowable compressive strength (f'c) at 28 days shall be the compressive strength determined from the

correlation of compressive strength with the minimum required flexural strength; but in no case shall the minimum 28-day compressive strength (f'_c) be less than 4,000 psi.

Separate correlation mix design tests shall be performed for each combination of cementitious materials and each combination of chemical admixtures proposed for use. Separate correlation mix design tests shall be performed for the different types of aggregates used. Separate correlation mix design tests shall be made for concrete for any conveying or placing method proposed which requires special properties. Changes in a mix design, other than those allowed by the Department, shall require a new mix design correlation.

(f) Steel.

Tie bars shall be deformed new billet steel; other bars shall be new billet steel. The Grade of the tie bars shall meet the requirements given in Article 835.05.

The material requirements given in Section 502 shall apply to the reinforcing steel for the concrete pavement.

Dowel bars shall be Type B meeting the requirements given in Article 835.05, unless otherwise noted by plan detail.

(g) Quality Control Plan and Maturity Meters.

1. Quality Control Plan.

The Contractor shall submit a Quality Control (QC) plan to the Materials and Tests Engineer for review. Construction shall not begin until the QC plan is accepted as being complete and has been distributed for inspection of the construction work. The Contractor shall include a description of the required Concrete Plant Laboratory as part of the QC plan. The Concrete Plant Laboratory shall meet the requirements of Section 601. No direct payment will be made for the laboratory.

2. Maturity Meters.

"Maturity Meters" may be proposed only for use in estimating the compressive strength of the concrete for opening the pavement to traffic.

The use of the maturity meters shall conform to the requirements given in ALDOT-425, “Maturity Method to Determine Early-Age Strengths of Concrete”.

The maturity meters used in establishing the Strength-Maturity relationship shall be the same ones used in estimating the early age compressive strength of the concrete in the pavement. The manufacturer's serial number of the maturity meter shall be shown on each strength-maturity relationship submitted to the Engineer.

When verification tests indicate the strength-maturity relationship is invalid, maturity testing shall be discontinued until a new strength-maturity relationship is developed. Compressive strength by testing cylinders shall be used for the determination of the early age compressive strength until the Contractor completes testing to reestablish the correlation between the early age compressive strength and the maturity meter readings.

(h) Sampling and Inspection.

1. Availability of Plant and other Facilities for Inspection.

Preparation of the mix shall be subject to inspection at all times. The Engineer shall have access at any time to all parts of the plant and other facilities for inspecting and checking all equipment, operations, and materials involved in preparation of the concrete mix. Any unsatisfactory equipment or operation shall be changed and improved as required.

2. Mainline Pavement Lot.

A mainline pavement lot shall be defined as 528 feet, or fraction thereof, of mainline roadway lane length placed in one paving pass. The paving width may be multiple roadway lanes placed in one paving pass. A complete lot shall be removed and replaced in accordance with the details shown on the plans if the quality of the pavement in any portion of the lot is determined to be unacceptable.

Concrete shoulder pavement placed integrally with mainline roadway may be accepted using the tests for the mainline roadway pavement. The Engineer may include transitional areas of pavement adjacent to mainline lots for acceptance using the tests for the mainline roadway pavement.

A paving pass is defined as the continuous paving operation in width and length done without interruptions of more than 30 minutes.

3. Non-Mainline Pavement Lot.

Ramps, shoulders, and transitional areas are classified as non-mainline pavement. A non-mainline pavement lot shall be defined as 250 cubic yards, or fraction thereof, of ramps, shoulders, and transitional areas placed in one paving pass. A complete lot shall be removed and replaced in

accordance with the details shown on the plans if the quality of the pavement in any portion of the lot is determined to be unacceptable.

The Engineer may combine ramps, shoulders, and/or transitional areas into one lot if the combined elements are placed in the same paving pass.

A paving pass is defined as the continuous paving operation in width and length done without interruptions of more than 30 minutes.

4. Table of Sampling and Testing Requirements.

SAMPLING AND TESTING REQUIREMENTS FOR ACCEPTANCE OF PORTLAND CEMENT CONCRETE PAVEMENT[1]						
	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Remarks
1. Compressive Strength	Minimum of One Set of Cylinders[2]	AASHTO T 141	ALDOT-210	AASHTO T 22 & AASHTO T 23	Minimum of 1 set per Lot	Sampled and Tested by the Department
2. Total Air Content	Minimum of One	AASHTO T 141	Same location and sample as 1	AASHTO T 152	Minimum of 1 per Lot	Sampled and Tested by the Department
3. Slump	Minimum of One	AASHTO T 141	Same location and sample as 1	AASHTO T 119	Minimum of 1 per Lot	Sampled and Tested by the Department
4. Temperature	Minimum of One	AASHTO T 141	Same location and sample as 1	AASHTO T 309	Minimum of 1 per Lot	Sampled and Tested by the Department
5. Thickness[3]	Probing Method		ALDOT-210		Minimum of 2 sets per Lot	Contractor shall perform measurements

Notes:

1. Sampling and testing frequency applies for both mainline and non-mainline portland cement concrete pavement.
2. A set of cylinders consist of two 6 in x 12 in cylinders to be tested at 28 days.
3. The Department will verify the Contractor's measurements by an alternative method for measuring thickness as indicated in Item 450.02(h)10. A set consists of two individual measurements.

5. Samples For Testing By The Department.

The Contractor shall furnish, without extra compensation, samples of materials for making test specimens and performing tests as required to comply with Departmental material testing procedures. Additional materials and increases in the frequency of testing will be required if deemed necessary by the Engineer.

The Engineer will establish the location for sampling in accordance with the requirements given in ALDOT-210, "Selecting Samples by the Random Numbers Method".

6. Sampling and Testing of Aggregates and Cementitious Materials.

Aggregates and cementitious materials shall be from approved sources accepted in accordance with the requirements given in the Department's Testing Manual.

7. Testing Concrete During Mixing and Placement.

A department certified ALDOT Concrete Technician will sample and test the properties of the concrete as it is being mixed and placed. Sampling and testing for total air content, slump, and temperature will be performed at the same time, and from the same sample that compressive strength samples are taken. Concrete that is not within the following limits during placement shall not be used:

- SLUMP: Slump will be determined in accordance with AASHTO T 119, "*Slump of Hydraulic Cement Concrete*" and shall not exceed the maximum specified slump.
- TOTAL AIR CONTENT: Total air content will be determined in accordance with AASHTO T 152, "*Air Content of Freshly Mixed Concrete by the Pressure Method*", Type "B". Total air content shall be between 2.0 % and 6.0 % by volume.
- CONCRETE TEMPERATURE: Concrete Temperature will be determined in accordance with AASHTO T 309, "Temperature of Freshly Mixed Portland Cement Concrete". The temperature of the concrete, at the time of placement, shall not be less than 50 ºF or more than 90 ºF.

8. Concrete Cylinders for Testing Compressive Strength for Acceptance.

The Department's certified ALDOT Concrete Technician will make a minimum of one set of two 28 days concrete cylinders that will represent the lot. Concrete cylinders will be made in accordance with AASHTO T 23, "Making and Curing Concrete Test Specimens in the Field". The compressive strength of concrete cylinders at 28 days will be determined in accordance with AASHTO T 22, "Compressive Strength of Cylindrical Concrete Specimens".

The concrete cylinders shall be initially cured in a protected environment in accordance with the requirements given AASHTO T 23. The protective environment shall be available at the time of the concrete placement and shall be maintained until all specimens have been transported to the testing laboratory. The Contractor shall furnish, without extra compensation, a protected environment for all concrete test specimens. The protective environment shall consist of at least one curing box (more may be required) with a capacity to hold at least 22 test cylinders that are 6 inch x 12 inch in size. Each curing box shall be equipped with heating/cooling capabilities, automatic temperature control, and a maximum/minimum (high/low) temperature readout. The protective environment shall be approved by the Area Materials Engineer prior to beginning any concrete placement.

9. Probing Method for Determining Concrete Pavement Thickness.

The Engineer will select using ALDOT-210 a minimum of two longitudinal locations within the lot to be measured. The Engineer will then select using ALDOT-210 two transverse locations within the width of the pavement at each of the longitudinal locations selected. The Contractor shall use a probing device to determine the concrete thickness of the freshly placed concrete at each of the locations selected. The thickness measurements shall be recorded to the nearest ⅛ of an inch. The two measurements at each longitudinal location constitute one set. The Contractor shall submit the record of all reading as well as the exact location, including the station number and offset, of each reading to the Engineer by the end of the day. The average of all the measurements within a lotwill be used by the Engineer to determine the thickness of the lot.

10. Verification of Contractor's Determination of Concrete Pavement Thickness.

The Department will use the Magnetic Imaging Technology (MIT) Scan-T2 to verify the Contractor's measurements of the concrete pavement thickness.

The engineer will set targets within one foot from the location of the Contractor's measurements. The Engineer will take two readings at each target location. The average of all the MIT Scan-T2 readings within a lot will be used by the Engineer to verify the thickness of the lot. The Engineer will record the station number and offset of the location the thickness measurements are taken.

If the Contractor's average thickness of the lot varies from the verification thickness done by the Department by ± 0.10 inches, a referee core sampled in accordance with AASHTO T 24 will be extracted at a location selected using ALDOT-210 from all the measured points. The core will be measured by the Department for thickness in accordance to AASHTO T 148. If the referee core thickness agrees with the Department's verification result, the Contractor will bear the cost of coring and repairing of the core hole. If the referee core thickness agrees with the Contractor's result, the Department will bear the cost of coring and repairing of the core hole. All voids resulting from coring operations shall be filled and consolidated with the same concrete mixture used during paving. Voids shall be filled on the same day that the cores are extracted using the same concrete mixture used for paving.

450.03 Construction Requirements.

(a) Placement of Concrete.

Concrete shall be placed in one lift of concrete. Separate lifts of concrete will not be allowed.

(b) Equipment.

1. Certification of Concrete Batch Plants.

All concrete batching plants shall be certified by the National Ready Mix Concrete Association (NRMCA) to be in conformance with the NRMCA Plant Certification Checklist. The concrete producer shall submit proof of NRMCA certification to the Area Materials Engineer prior to any batching of concrete.

All concrete batching plants used in the production of concrete pavement for the Department shall be on List I-7, "Portland Cement Concrete Producers", in the Department's Materials, Sources, and Devices with Special Acceptance Requirements manual. Concrete producers who request that their concrete batching plants be placed on List I-7 shall meet the requirements outlined in ALDOT-

355, "General Information Concerning Materials, Sources, and Devices With Special Acceptance Requirements".

2. Scales.

The scales for determining the weight {mass} of aggregates, mineral admixtures, and cement shall be an integral unit of the batching plant and meeting the requirements of Subarticle 109.01(h).

3. Concrete Mixers.

Concrete may be mixed at the site of construction or at a central point. Each mixer shall have attached to it in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades for both mixing and agitation.

An automatic graduated measuring device, accurate within three percent shall be provided at the mixer for measuring each amount of air-entraining agent and other chemical admixtures to be added to each concrete batch requiring such admixture.

Mixers shall be equipped with an approved device for accurately measuring water within ± 1% of the reading indicated. The requirements given in Subarticle 501.03(b) apply for concrete transit mixers.

4. Spreading and Finishing Equipment.

Minimum spreading and finishing equipment shall consist of a mechanical spreader and/or strike-off screed, a finishing machine, vibrators for full width vibration of the paving slab, smoothing float, 16 foot straightedge, floats, burlap drags, and curing equipment.

5. Vibration Equipment.

Vibration equipment shall be used to vibrate the concrete for the full width and depth of the pavement without coming in contact with steel bars, other internal materials and the underlying layer. The vibration equipment shall be capable of being stopped when the vibration equipment is not moving along the pavement.

Internal (spud or tube) and surface (pan) vibrators shall be used. Spud or tube vibrators shall operate at a frequency between 5000 to 8000 vibrations per minute. Pan vibrators shall operate at a frequency between 3000 to 6000 vibrations per minute.

6. Concrete Saws.

Equipment shall be provided for the sawing of joints. An adequate number of saws shall be utilized to complete the sawing within time to prevent cracking of the concrete.

7. Forms.

Forms shall be substantial enough in size and strength to allow the proper placement and finishing of the concrete.

8. Lighting.

Lighting shall be in accordance with the requirements given in Subarticle 104.04(a).

(c) Precipitation and Temperature.

1. Precipitation.

Pavement damaged by rain or hail shall be removed and replaced in accordance with the details shown on the plans without additional compensation.

2. Temperature.

a. Range of Acceptable Concrete Temperature for Placement.

The temperature of the concrete, at the time of placement and spreading, shall not be less than 50 ºF or more than 90 ºF.

b. Cold Weather Operations.

Concrete shall not be placed on an underlying surface that is colder than 35 °F.

When concrete is placed during seasons when there is a probability of ambient temperatures lower than 40 °F, heating equipment and materials shall be available to protect the concrete from the cold weather. The heating equipment and materials shall be used to enclose the uncured concrete and keep the air temperature inside the enclosure within the allowable ranges of temperature for the minimum required amount of time.

If there is a possibility that ambient temperatures will be below 40 °F during the first three days after placement of concrete, the concrete shall be protected from cold temperatures by keeping the surface at a temperature above 50 °F for the first 72 hours after placement and above 32 °F for an additional 72 hours. After these periods of time, the protective covering shall remain

in place until the temperature inside the protective covering reaches that of the surrounding atmosphere.

The Contractor shall furnish two "continuous temperature reading" thermometers for the measurement of the concrete surface temperature. The measurements shall me made as directed by the Engineer.

The aggregates and mixing water shall not be heated to a temperature in excess of 150 °F. Aggregates from frozen stockpiles shall not be incorporated into the mix. Materials entering the mixer shall be free from ice, snow, and frozen lumps. Salts, chemicals, or other materials shall not be incorporated in the concrete to prevent freezing. Care shall be taken to heat all materials uniformly and avoid hot spots that will burn or overheat the materials.

c. Hot Weather Operations.

If there is a possibility that ambient temperatures will be above 90 °F during the placement of concrete an approved retarder admixture shall be used in the concrete mixture. Cooling of the mixing water and/or aggregates or placing the concrete during the cooler part of the day may be allowed to keep the concrete below the maximum allowable temperature. In no instance shall a concrete mixture be placed when the temperature of the concrete is above 90 °F {32 °C}. Concrete shall not be placed against any surface (in particular steel surfaces) when the temperature of that surface is greater than 120 ºF. Surface watering may be used to cool the surface that the concrete will be placed on if it is at or above 120 °F, but standing water will not be allowed at the time of concrete placement.

Concrete placement will only be allowed at night if the temperature of the concrete is above 90 °F and cannot be lowered or if the temperature of the surface that the concrete will be placed on is above 120 °F and cannot be lowered.

(d) Preconditioning of Underlying Layer prior to Placement of Concrete.

All high areas of the layer under the concrete shall be corrected before the concrete is placed. Low areas shall be filled with material integral with the underlying layer (HMA or concrete pavement).

The underlying layer shall be thoroughly wetted the previous night but not less than six hours prior to placing of the concrete. The underlying layer shall be sprinkled just before the placement of the concrete so as to be uniformly moist. The method of sprinkling shall not result in mud or pools of water.

(e) Fixed Forms.

Fixed forms shall not be used for mainline pavement (including shoulders) when the total amount of concrete pavement required to be placed is greater than 10,000 square yards.

Fixed forms shall be used in areas where slip form pavers cannot be used such as areas with a sharp radius and at the transition areas of ramps.

(f) Slip Form Method.

1. Allowable and Required Use of Slip Form Method.

The slip form method shall be used when the total amount of concrete pavement required to be placed is greater than 10,000 square yards. The slip form method may be used instead of fixed forms when the total amount of concrete pavement required to be placed is less than 10,000 square yards.

2. Slip Form Paver.

The slip form paver shall be designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the paver. Concrete shall be placed so that only minor hand finishing will be necessary to provide a dense and homogeneous concrete pavement.

The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed. The vibration shall be accomplished with the required vibration equipment.

The sliding forms shall be rigidly held together, laterally to prevent spreading of the forms, and shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur.

The paver shall be operated with a continuous forward movement. All operations of mixing, delivery, and spreading concrete shall be coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

All tractive force applied to move the paver shall be operated by controls on the paver.

3. Edge Slump.

The edge slump shall be measured within an area that is 6 inches from the longitudinal edges of each pavement slab.

The edge of the finished surface shall not vary more than 1/4 of an inch from a 10 foot straightedge placed perpendicular (at a right angle) to the edge of the outside of the pavement slab or to the edge of a pavement slab that is adjacent to another pavement slab.

Pavements slabs where the edge slump is excess of the allowable amount (1/4 inch) shall be removed and replaced in accordance with the details shown on the plans without additional compensation.

(g) Placing Concrete.

1. Water Evaporation Rate During Placement.

Prior to and during the placement of concrete, the water evaporation rate shall be determined in accordance with the requirements given in Section 501 for bridge deck slabs. Preventive action shall be taken to eliminate plastic shrinkage cracking in accordance with the requirements given in Section 501.

2. Reduction of Evaporation during the Screeding Operations.

If the evaporation rate measured in accordance with the requirements given in Section 501 exceeds the maximum allowable rate, continuous fogging or an evaporation barrier material (monomolecular film) shall be used to maintain moisture on the surface of the pavement. Continuous fogging or an evaporation barrier shall be applied to the pavement no further than five feet behind the screeding operations.

If fogging is used, a continuous fog or mist spray shall be maintained until the curing procedures begin. Intermittent fogging is not acceptable if there is drying of the concrete surface. If water begins to pond on the pavement, the Contractor shall adjust the rate of fogging to minimize the ponding of water.

If an evaporation barrier material is used, it shall be applied immediately behind the screeding operation. The entire top portion of the concrete slab shall be covered with a uniform film of the barrier material. The rate of application and the means of application shall be in accordance with the manufacturer's recommendations. The Contractor shall submit the manufacturer's recommended application procedures to the Engineer at least 7 days prior to the placement. Acceptable evaporation barrier products will be listed on the plans.

3. Concrete in Adjacent Slabs.

Where concrete is placed adjacent to a previously placed concrete pavement, the previously placed pavement shall have attained a compressive strength of at least 3000 psi as determined by tests of standard specimens cured under the same climatic and moisture conditions as the concrete pavement, unless other means of determining the compressive strength are allowed by the Engineer.

4. Vibrators.

Vibrators shall not come in contact with a joint assembly, the layer under the concrete or forms. Single unit vibrators shall be used along the side forms, joints, and at other locations not thoroughly vibrated by the vibrator assembly. In no case shall the vibrator be operated longer than 15 seconds in any one location. Carriage mounted vibrators shall be equipped to cut off automatically when the vibrator carriage stops. Vibration shall be completed ahead of the finishing machine screed.

(h) Expansion Joints.

Expansion joint assemblies shall be installed in proper sequence ahead of placement of concrete. Concrete shall be deposited as near to an expansion joint as possible without disturbing it.

(i) Placement of Steel.

Care shall be taken before and during paving operations to ensure that steel, including reinforcing steel, dowels and tie bars will stay within the plan tolerances after the finishing operations.

(j) Joints.

1. Establishing Location of Joints.

The Contractor shall be responsible for marking locations of joint steel in advance of placement of concrete so that sawed joints will be properly located over dowels and tie bars.

2. Sawing Concrete for Joint Construction.

All joints except expansion joints shall be prepared by sawing. Sawing shall be done with a concrete saw equipped with a guide frame or other approved device that will assure cutting of the joint within 1/4 of an inch of the designated alignment and to the required joint size shown on the plans. All vertical joints shall be constructed perpendicular to the pavement surface.

Because of the importance of sawing the joints at the proper location and at the proper time, early sawing is imperative.

All uncontrolled cracked pavement shall be removed and replaced in accordance with the details shown on the plans without additional compensation from the Department.

3. Types of Required Joints.

Joints shall be constructed of the type, dimensions, lengths, arrangement, spacing, and at the locations shown on the plan. A joint shall be a designed separation, formed by material extending full depth of the slab or a saw cut extending part way through the slab.

A contraction joint is a transverse joint located at regular intervals in a slab to control transverse cracking or at other designated sites to control longitudinal cracking.

An expansion joint is one providing space for expansion of the slab without damage. For clarity, all expansion joints, including those in intersections at any angle, are regarded as transverse joints.

A construction joint is one made necessary by interruption of more than 30 minutes in continuous placing of concrete, including a transverse joint placed at the end of a day's operation or at the point of a breakdown, or a longitudinal joint where adjacent lanes are constructed at different times.

Longitudinal joints shall be constructed coincident with or parallel to the pavement centerline. Transverse joints shall be constructed as shown on the plans.

4. Tie Bars for Longitudinal Joints.

a. Tie Bar Location and Strength.

Deformed steel tie bars shall be placed perpendicular across the longitudinal joints at the location and at the spacing shown on the plans. The required strength of the tie bars will be shown on the plans.

b. Tie Bars in Fixed Forms.

When using the fixed form method, the use of a keyway with a sectional tie bar or a straight tie bar bent against the form of the first slab constructed is acceptable.

c. Tie Bars in Slip Form Paving.

When using the slip-form method, the tie bars shall be inserted in the fresh concrete or anchored in appropriately sized holes drilled into the previously placed pavement.

Drilled holes shall not be greater than 1/8 inch larger than the diameter of the tie bar. Drilling of holes will not be allowed until the concrete has obtained a compressive strength of 2500 psi or is seven days old. Tie bars shall be anchored in the drilled holes with an approved adhesive material meeting the requirements given in Article 870.04.

Tie bars shall meet a 7200 pound, minimum, pull-out requirement. The Department will perform the pull-out tests in accordance with ALDOT-366, "Test Method for Pull Out on Steel Tie Bars Secured in Concrete with Epoxy". The Contractor shall supply the equipment necessary to perform the pull-out test. The equipment shall be suitable for the performance of the tests at the frequency specified in Section 450 of the Acceptance Sampling and Testing Schedule of the Testing Manual. There will be no direct payment for the pull-out test equipment furnished by the Contractor for use by the Department.

5. Weakened Plane Joint for Adjacent Lanes Constructed Simultaneously.

A weakened plane joint shall be constructed by sawing the concrete when adjacent lanes of pavement are constructed at the same time by the simultaneous placement of concrete. The requirements for the size and sealing of the weakened plane joint are shown on the plans. The joint shall be sealed with an approved joint sealer.

6. Dowel Bars for Transverse Joints.

Dowel bars shall be installed as shown on the plans. The dowel bars shall be installed with a supporting assembly capable of rigidly maintaining the dowel bars in the proper horizontal and vertical alignment during and after the concrete placing and finishing operations.

Dowel bars shall have the ends ground or dressed to eliminate any projections due to cutting operations.

Dowel bars at expansion joints shall have a cap or sleeve over the expansion length (length embedded in one slab) of each bar with one end of the sleeve fitting tightly around the bar and the other end closed and watertight. The cap or sleeve shall be provided with an expansion space not less than the width of the joint being constructed.

7. Transverse Expansion Joints.

The transverse expansion joints shall be constructed in accordance with the details shown on the plans. Dowels and supports shall be assembled off the underlying layer and shall be placed into position as a unit.

8. Transverse Contraction Joints.

Transverse contraction joints shall consist of planes of weakness created by sawing grooves in the surface of the pavement in accordance with the details shown on the plans. All contraction joints shall be sealed as shown on the plans.

9. Transverse Construction Joints.

Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. A transverse construction joint shall not be constructed within 10 feet of an expansion or contraction joint. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete shall be removed back to the last preceding joint.

The construction joint shall be formed by placing the concrete against a header board set so as to form a joint at right angles to the pavement centerline vertically and horizontally. The board shall be shaped to the cross slope of the pavement and shall be sufficiently rigid to prevent bending or movement during finishing operations.

Grinding, in accordance with Item 450.04(b)2, will be allowed for a distance of 25 feet either side of the construction joint or header that is placed when the paving operation ends each day regardless of the type of aggregate used in the concrete mix design.

(k) Surface Smoothness and Cross Slope.

1. Measurement of Surface Smoothness and Cross Slope,

Surface smoothness shall be checked by the use of straightedges, levels and strings. The Contractor shall furnish levels, straightedges, string, and the personnel to make and record measurements as directed by the Engineer.

2. Surface Smoothness.

Surface smoothness tests shall be made continuously during and after concrete placement so that irregularities may be reduced while the concrete is still workable.

The finished surface shall not vary more than 1/4 of an inch from a 12 foot straightedge placed perpendicular (at a right angle) to the centerline of the roadway anywhere on the surface.

The surface shall not vary more than 1/4 of an inch from a 16 foot straightedge placed parallel to the centerline anywhere on the surface.

The finished surface shall not vary more than 3/8 of an inch in any 25 foot section from a taut string applied parallel to the surface. The surface shall be checked one foot inside of the edges of pavement, at the centerline, and at other points designated by the Engineer. The tolerance from the designated grade shall not exceed plus or minus 1/2 of an inch in 100 feet.

3. Cross Slope.

The required cross slope shall not vary by more than 0.20% from the required slope in any 12-foot distance over which the slope is measured. (If, for example, a 2.0% slope is required, the measured cross slope shall not be greater than 2.2% or less than 1.8%.)

Pavement that is not within the required cross slope tolerance shall be replaced in accordance with the details shown on the plans without extra compensation.

(l) Finishing.

1. Sequence of Finishing Requirements.

After the concrete has been placed, consolidated, and struck off, the finishing, floating, surface corrections, texturing, and edging shall be performed.

2. Transverse Finishing.

A finishing machine shall be used to screed the surface of the concrete to a uniform texture and to the required grade and cross slope.

3. Float Finish.

After transverse finishing, further finishing shall be performed by the means of a float.

4. Preliminary Straightedging and Surface Correction.

After the finishing has been completed and the excess water removed, but while the concrete is still workable, the surface of the concrete shall be tested by the Contractor with an accurate 16 foot floating straightedge.

Depressions in the surface shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. The surface across joints shall meet the requirements for smoothness. Straightedge testing and surface correction shall continue until the entire surface is found to conform to the straightedge and the slab conforms to the required grade and cross slope.

5. Surface Texture.

The pavement surface shall be finished with a burlap drag. The burlap drag finish shall consist of dragging longitudinally along the full width of the pavement with a seamless strip of damp burlap or cotton fabric which will produce a gritty texture. The drag shall be maintained in such condition that the resultant surface is of uniform appearance. Drags shall be maintained clean and free from encrusted mortar. Drags which cannot be cleaned shall be discarded.

Immediately after the pavement has been finished by the burlap drag, the surface shall be transversely grooved. Transverse grooving shall be produced by mechanical equipment designed for grooving plastic concrete utilizing rectangular shaped spring steel tines of uniform length that will produce clean cut transverse grooves in the hardened surface. The tines shall be spaced at intervals of at least 3/8 of an inch apart up to a maximum spacing of ½ of an inch. The tines shall produce grooves in the hardened surface which are from 0.080 to 0.130 of an inch in width and from 0.125 to 0.188 of an inch in depth.

The completed transversely grooved surface finish shall meet the groove depth requirements given in ALDOT-248, "Method of Test for Measuring the Depth of Grooves in Concrete Pavements and Bridge Decks with a Tire Tread Depth Gauge", and all straightedge requirements. Any grooved surface damaged or destroyed may be restored if the concrete is still plastic; otherwise, it shall be regrooved after the concrete has obtained its designed strength. Grooving after the concrete has hardened shall be done by equipment designed specifically for grooving pavements.

(m) Curing.

1. Duration of Curing.

Immediately after the finishing operations have been completed and as soon as marring of concrete will not occur, the entire pavement surface shall be cured for a minimum period of 72 hours.

2. Optional Curing Methods.

The Contractor shall cure the concrete by either placing an impervious membrane or by moist curing. The curing method chosen by the Contractor shall be sufficient to prevent plastic shrinkage cracking.

a. Curing by Using an Impervious Membrane.

The impervious membrane shall meet the requirements given in Section 830.

The impervious membrane material shall be applied in accordance with the requirements given in Section 830 except that the rate of application shall be a minimum of 1 gallon per 100 square feet of surface area or a greater rate if recommended by the manufacturer. The impervious membrane material shall be applied under pressure by mechanical sprayers. Spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be thoroughly mixed. During application, the compound shall be stirred continuously by mechanical methods. Hand spraying of areas of irregular widths or shapes and on surfaces exposed by form removal will be permitted. When hand spraying is used the membrane material shall be applied in two applications.

The impervious membrane shall not be applied to the inside faces of joints to be sealed.

b. Moist Curing

Moist curing shall be either by fog spraying or by saturated burlap or burlap sheeting in accordance with the following.

1. Fog Spraying:

Fog spraying shall be done with nozzles or sprinklers designed for this purpose. When using this method, the Contractor shall maintain a complete and continuous moist condition of the

concrete surface. Intermittent fog spraying is not acceptable. Care shall be taken that erosion of the surface does not occur.

2. Burlap or Burlap Sheeting:

Saturated burlap or saturated white-burlap-polyethylene sheeting may be used for curing. The burlap and white-burlap-polyethylene sheeting shall be furnished in accordance with the requirements given in Section 830. These curing materials shall be clean and free from any injurious substances that can cause deleterious effects to the concrete or cause discoloration. The burlap and burlap sheeting shall be completely saturated before being placed on the concrete and shall be maintained in that condition for the entire curing period. All edges of burlap and burlap sheeting shall extend at least 18 inches beyond the concrete surface. Where two individual sheets join, their edges shall overlap at least 12 inches. All edges and overlaps shall be secured to ensure that the concrete surface is completely covered during the entire curing period. The burlap material shall be kept in contact with the concrete surface at all times. Alternate cycles of wetting and drying will not be allowed.

(n) Sealing Joints.

Before the pavement is opened to traffic, and as early as is feasible, all joints, both longitudinal and transverse, shall be filled with joint sealing material of a type specified by the plans. The joint faces shall be clean and surface dry when the seal is applied. Suitable tools for installing the seal to the proper depth and dimensions shall be used. The joints to be sealed with Hot Poured Sealants or Cold Poured Sealants shall be sealed as outlined in Section 454. Preformed Elastomeric Joint Seals shall be installed in accordance with the manufactured recommendations and the details shown on the plans.

(o) Removal of Forms.

Forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. They shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the ends of all joints shall be cleaned, after which the sides of the slab shall be covered with earth or other approved curing agent.

As soon as the side forms have been removed, any defective work shall be removed and replaced in accordance with the details shown on the plans. Any area or section so removed shall be not less than 10 feet in length and not less than the full width of the lane involved. If the area to be removed extends to a point less than 10 feet {3 m} from a joint, it shall be extended on to the joint.

(p) Reinforced Bridge End Slabs.

Special pavement slabs, reinforced as shown on the plans, shall be constructed adjacent to bridges using concrete of the same type and proportions that are in the adjoining concrete pavement. No direct payment will be made for reinforcing steel used in the bridge end slabs.

The end slabs shall be constructed in the same manner required for the construction of concrete pavement. Where the bridge end slab will be covered with a bituminous overlay, the final screeding of the surface of the concrete shall be done by any means that will leave a slightly roughened surface. Where the bridge end slab will not have a bituminous overlay, the final screeding of the surface of the concrete shall be done with a mechanical longitudinal screed and the hardened surface of the concrete shall be machine grooved in accordance with the requirements given for grooving the surface of concrete bridge decks.

(q) Protection of Pavement.

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. Any material deposited on the pavement considered detrimental to the surface shall be removed immediately. This requirement shall include erection and maintenance of warning signs, lights, watchmen to direct traffic, pavement bridges, or crossovers, etc., as needed or directed by the Engineer.

(r) Opening Pavement to Traffic.

The Contractor shall protect the concrete pavement from vehicular traffic during the curing period. Completed portions of the concrete pavement may be opened to light construction traffic only (small pick-up trucks with four wheels and cars) when the compressive strength of the concrete pavement reaches 3000 psi but not earlier than 72 hours. Traffic shall not be parked on the pavement during the curing period and any curing compound and/or moisture removed by the traffic tires shall be replaced immediately.

The Contractor may utilize "Maturity Meter" measurements for the determination of the compressive strength of the concrete. The compressive strength required for opening the pavement to

traffic shall be determined by tests of standard concrete cylinders cured under the same climatic and moisture conditions as the slab unless maturity meters are used.

The pavement may be opened to unrestricted traffic after 7 days if the 28-day compressive strength has been achieved and the Engineer has accepted the pavement without restriction.

If the ambient temperature drops below 40 ºF, the period of time that the temperature is below 40 ºF will be added to the minimum time to opening. Any part of the pavement damaged by traffic or other causes prior to its final acceptance shall be repaired or replaced at no additional cost to the Department in a manner acceptable to the Engineer.

450.04 Smoothness Requirements.

(a) Testing Device.

1. Description.

The testing device shall be an inertial profiler that satisfies the requirements of ALDOT-448, "Evaluating Pavement Profiles," including the portable storage device(s) referenced herein. Portable storage devices containing profile measurements shall become the property of the Department at the time the measurements are taken.

2. Equipment Requirements.

The inertial profiler shall be a certified, non-contact, laser-based device capable of simultaneously measuring both wheelpaths meeting all the requirements of ALDOT-448.

Portable storage device(s) for the inertial profiler shall be furnished in sufficient quantities for all calibration, test runs, and actual tests deemed necessary by the Engineer. Unless approved in advance by the Engineer, all portable storage devices provided by the Contractor will take the form of commonly available 2G USB flash drives.

(b) Testing Procedure.

1. Description.

Smoothness testing shall be conducted in accordance with the requirements given in ALDOT 448. The Contractor shall furnish the necessary certified personnel to operate the inertial profiler.

The smoothness test shall be performed as soon as practical after the pavement hardens sufficiently to prevent damage to the surface finish but no later than the next work day after placement of the concrete, unless otherwise authorized by the Engineer.

The smoothness test is considered a part of the paving operation and will be performed immediately in the proper sequence, in a satisfactory manner, even to the exclusion of other work.

Smoothness testing shall be performed and reported daily until the contractor demonstrates the ability to achieve a Mean Roughness Index (MRI) value of less than 65 in/mile. If the Contractor demonstrates the ability to achieve a MRI value of less than 65 in/mile then the Contractor may elect to perform and report the smoothness testing at a frequency he determines but not to exceed 5 working days production.

2. Smoothness Requirements.

The results of the inertial profiler tests will be evaluated by Department personnel as outlined in ALDOT-448.

If a Mean Roughness Index (MRI) value of 90 inches per mile {1.4 m/km} is exceeded in any test section of any daily paving operation, the paving operation will be suspended as soon as possible after results of the unacceptable test section are obtained. The paving will not be allowed to resume until corrective action is taken by the Contractor.

The contractor will be allowed to diamond grind and groove any test section whose Mean Roughness Index exceeds 65 inches per mile; except when the concrete mix design uses more than 50 percent carbonate stone. All diamond grinding and grooving shall be performed with no additional compensation from the Department. Diamond grinding may be separate locations of grinding or continuous grinding within a test section. Diamond grinding at any location shall be for the full width of the pavement test section.

Diamond grinding & grooving equipment, including such required to remove slurry and residue, shall meet the requirements of Section 455.

The grinding process shall produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. Said line type texture shall consist of parallel longitudinal corrugations of between 50 and 60 evenly spaced grooves per foot {300 mm} with the ridges approximately 1/32 of an inch {1 mm} higher than the bottom of the grooves. The Contractor shall select an appropriate number of blades per foot, dependent upon the coarse aggregate used in

the concrete pavement mixture. For concrete containing harder coarse aggregate, including granite, quartzite, sandstone and gravel, 55-60 blades per foot shall be used.

Joints and cracks shall be visually inspected to ensure that adjacent surfaces are in the same plane. Misalignment of the surface planes of adjacent sides of joints or cracks which is in excess of 1/16 of an inch {2 mm} shall be ground until the surfaces are flush.

The transverse slope of the ground pavement shall be uniform to a degree that no depressions or misalignment of slope greater than 1/4 of an inch {6 mm} in 12 feet {3.5 m} are present when tested with a 12 foot {3.5 m} straightedge placed perpendicular to the pavement centerline. Straightedge requirements do not apply outside of the ground areas.

The Contractor shall also longitudinally diamond groove any section of pavement that has been diamond ground. Grooves shall be approximately 1/8 inch {3 mm} wide and 1/8 inch {3 mm} deep, and constructed on 3/4 in {19 mm}, ±1/16 in {1.5 mm}, center-to-center spacing parallel to the centerline of the roadway. Grooves shall not be cut closer than 6 inches {150 mm} to any adjacent joint, nor shall they overlap. If diamond grinding is performed the measurement of pavement thickness for acceptance and payment will be made after diamond grinding is completed. The determination of the pavement thickness will be by coring a location determined by the Engineer using ALDOT-210. The Contractor will be responsible for cost of coring and repairing the core hole. All voids resulting from coring operations shall be filled and consolidated with the same concrete mixture used during paving. Voids shall be filled on the same day that the cores are extracted using the same concrete mixture used for paving. Price adjustments will be made for smoothness after the diamond grinding is completed. All test sections of pavement where the Mean Roughness Index remains greater than 90 inches per mile {1.4 m/km} shall be removed and replaced (in accordance with the details shown on the plans) by the Contractor without additional compensation.

The price adjustments for smoothness are given in Subarticle 450.08(b).

450.05 Tolerance in Pavement Thickness.

Pavement (main roadway, shoulders, intersections, entrances, crossovers, ramps, etc.) thicknesses will be checked by the Department for compliance with required thickness by measuring the length of cores or by the use of MIT Scan T2 device. Pavement with deficient thickness will be paid for on an adjusted unit price as described in Subarticle 450.08(b). Thickness measurements shall be made after all operations, if applicable, have been performed to improve smoothness.

Pavement that is deficient from the required thickness by more than 0.75 inches shall be replaced in accordance with the details shown on the plans at no cost to the Department.

450.06 Acceptance of Concrete Based on Compressive Strength.

Concrete cylinders, 6 inches x 12 inches in size, will be made by the Department from randomly selected concrete batches in each lot as designated by the Engineer.

The compressive strength shall be the average of two cylinder test results. If the average compressive strength of the cylinders is equal to or greater than 100 % of the required 28-day compressive strength, the concrete will be accepted with no price reduction.

If the average compressive strength of the cylinders is less than 100% of the required 28-day compressive strength, the Department may conduct a coring investigation in accordance with ALDOT-457 to determine the equivalent average 28-day in-place strength of the lot represented by the cylinders in question.

If the equivalent average 28-day compressive strength of the cores is equal to or greater than 90% of the specified 28-day compressive strength, the lot will be accepted with no price adjustment.

If the equivalent average 28-day compressive strength of the cores is less than 90% but greater than or equal to 75% of the specified 28-day compressive strength, the lot will be accepted with a price reduction, as defined in Subarticle 450.08(b).

If the equivalent average 28-day compressive strength of the cores is less than 75% of the specified 28-day compressive strength, the lot shall be removed and replaced in accordance with the details shown on the plans without additional compensation.

450.07 Method of Measurement.

The amount of concrete pavement to be paid for under this section shall be the number of square yards {square meters} of pavement completed and accepted, measured in place and calculated to the nearest square yard {square meter}. The width will be the width of the pavement shown on the typical cross section of the plans plus additional widening where called for, or directed by the Engineer in writing. The width will be the outside to outside measurement of the pavement including any area

covered by integral curb or concrete median strip. The length will be measured along the surface of the centerline.

Reinforced concrete bridge end slabs will be measured in square yards {square meters} and will be paid for separately.

The number of inertial profilers measured for payment will be the actual number of units ordered and accepted.

450.08 Basis of Payment, Price Adjustments and Pavement Replacement.

(a) General.

The square yardage {square meters} of concrete pavement and bridge end slab, measured as provided above, will be paid for at the contract unit price bid per square yard {square meter}, which payment shall be full compensation for furnishing and placing all materials, including any reinforcing steel and supports, anchor concrete, sleeper slab concrete, structural steel (except bridge joint armor plates), dowels, and all other joint material, any additives, and for all materials, equipment, tools, labor, and incidentals required to complete the work (including the finishing, grooving, or tining of the surface).

No additional payment over the contract unit bid price will be made for any pavement which has an average thickness in excess of that shown on the plans.

Integral curb, measured as provided above, will be paid for at the contract unit price per linear foot {meter} which shall be payment in full for all materials and work required in completing the item.

The ordered and accepted inertial profilers, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for furnishing the unit and includes all equipment, tools, labor, calibration, maintenance, services, supplies, chart paper, and incidentals necessary to complete these items of work.

(b) Price Adjustments and Deficiencies requiring Pavement Replacement.

1. General.

The descriptions of "mainline lot and non-mainline lot" are given in 450.02(h)2 and 450.02(h)3 respectively.

Mainline lots will be designated for acceptance and payment based on smoothness, concrete strength, and pavement thickness. Non-mainline lots will be designated for acceptance and payment based on concrete strength and pavement thickness.

2. Price Adjustment based on Smoothness.

The Mean Roughness Index shall be measured as noted in Subarticle 450.04(b).

When the MRI is more than 65 inches per mile {1.0 m/km}, per section, a unit price reduction will be assessed. When the MRI is less than 40 inches per mile {0.6 m/km} per section, a unit price increase will be added. The price adjustments are given in Table 1.

TABLE I

Mean Roughness Index Inches/Mile/Section {meters/Kilometer/Section}	Contract Price Adjustment Percent of Pavement Unit Bid Price
Under 35 {Under 0.6}	105
35 to less than 45 {0.6 to less than 0.7}	105 – (MRI -35)/ 2 {105 – (MRI – 0.6)/ 0.02)}
45 to less than 65 {0.7 to less than 1.0}	100
65 thru 90 {1.0 thru 1.4}	100 – (MRI – 65)/1.25 {100 – (MRI – 1.0)/0.02}
Over 90 {Over 1.4}	Unacceptable

Where diamond grinding is performed to bring the Mean Roughness Index to 65 inches per mile or less, payment for the test section will be a maximum of 100 % of the contract price.

3. Price Adjustment based on Pavement Thickness.

Where the thickness of pavement, measured as described in Article 450.05, is deficient from the required thickness, payment will be made at an adjusted price as shown in the following table.

PRICE ADJUSTMENT FOR DEFICIENCY IN PAVEMENT THICKNESS	
Deficiency in Pavement Thickness	Price Adjustment
Greater than 0.00" to less than or equal to 0.10"	100 %
Greater than 0.10" to less than or equal to 0.25"	90 %
Greater than 0.25" to less than or equal to 0.40"	80 %
Greater than 0.40" to less than or equal to 0.55"	70 %
Greater than 0.55" to less than or equal to 0.75"	60 %
Greater than 0.75"	Replace Pavement Testing Unit

4. Price Adjustment based on Compressive Strength.

Payment for concrete pavement will be adjusted based on compressive strength as described in Article 450.06.

If the average equivalent 28-day compressive strength of the cores is 85% or greater but less than 90% of the specified 28-day compressive strength, the lot will be accepted with an 85% price adjustment.

If the average equivalent 28-day strength of the cores is 75% or greater but less than 85% of the specified 28-day strength, and the Engineer deems the concrete to be structurally acceptable, the lot will be accepted with a 50% price adjustment.

5. Range of Price Adjustments and Assessment of Combined Price Adjustments.

The range of price adjustment based on smoothness is 105 % to 80 %.

The range of price adjustment based on pavement thickness is 100 % to 60 %.

The range of price adjustment based on compressive strength shall be 100 % to 50 %.

If more than one price adjustment is required, the product of the price adjustments (percentage price adjustments multiplied together) will be applied to the contract price for the pavement.

6. Deficiencies Requiring Pavement Replacement.

The pavement shall be removed and replaced without extra compensation if the following price adjustments occur:

- The Mean Roughness Index is greater than 120 inches per mile per section;
- The deficiency in pavement thickness exceeds 0.75 inches;
- The equivalent average 28-day compressive strength is less than 75% of the required compressive strength;
- The product of the price adjustments for pavement thickness and compressive strength in the pavement is less than 50 %.

Other conditions of deficiency may result in a requirement that the pavement must be removed and replaced without additional compensation.

(c) Payment will be made under Item No.:

450-A __*__ Cement Concrete Pavement, ___ inches {mm} Thick – per square yard {square meter}
450-B Reinforced Cement Concrete Bridge End Slab - per square yard {square meter}
450-C Integral Curb - per linear foot {meter}
450-H Smoothness Testing – Certified Inertial Profiler – per Each

* Plain, Reinforced, Plain High Early Strength, Reinforced High Early Strength, Continuous Reinforced

SECTION 452
SLABJACKING OF PORTLAND CEMENT CONCRETE PAVEMENT

452.01 Description.

The work covered by this Section consists of the raising and leveling of concrete pavements that have settled by the injection of grout under the pavement using hydraulic pressure to raise the pavement to its designated grade.

Due to the variations in quantities that can be experienced in this type work, the quantities for the items in this Section cannot be accurately determined before the work is done; therefore, the items in this Section shall be excluded from those items which may have their unit price adjusted as allowed by Subarticle 104.02(a). At any time during the life of the project, should any process or work herein be deemed ineffective or unnecessary by the Engineer, the Engineer may order any and/or all work under this Section stopped, reduced, and/or eliminated. In such case, the Contractor will be paid for all work ordered and performed. No claim will be considered because of elimination or reduction of work under this Section.

452.02 Materials.

(a) General.

Materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, and the requirements noted in this Article.

(b) Grout.

The grout used in slabjacking shall consist of one of the mixtures shown in Table I with the materials complying with the following:

Type I or III Cement - Article 815.01 and 815.03

Calcium Chloride - Section 805 Type I

Fly Ash - Section 806 Modified to waive the Loss on Ignition requirement

Water - Section 807

Admixtures - Sections 808 and 809

Limestone Dust - Limestone dust shall be thoroughly dry, free of lumps, meeting the following gradation requirements:

Size	% Passing by Weight {Mass}
No. 30 {600 µm} Sieve	100
No. 100 {150 µm} Sieve	90 - 100
No. 200 {75 µm} Sieve	65 - 100

Fine Sand - Fine sand shall comply with the appropriate requirements of Section 802 allowing the use of manufactured sand from limestone, sandstone or granite, or natural silica fine sand meeting the following gradation requirements:

Size	% Passing by Weight {Mass}
No. 10 {2.00 mm} Sieve	95 - 100
No. 60 {250 µm} Sieve	40 - 90
No. 200 {75 µm} Sieve	0 - 50
Percent Silt	0 - 25
Percent Clay	0 - 12
Percent Organic Material	0 - 3

Sand shall be non-plastic as determined by AASHTO T 89 and T 90.

452.03 Construction Requirements.

(a) Equipment.

The equipment for slabjacking of concrete pavement shall be that customarily used in the slabjacking of concrete pavement consisting of at least the following:

a. Air Compressors of sufficient capacity for operating pneumatic hammers.

b. A discharge pipe with an adequate securing device.

c. Pneumatic hammers equipped with drills that will cut 1.5 inch {38 mm} diameter or other approved diameter holes through the rigid pavement. The equipment shall be operated in such a manner so as to prevent unnecessary damage to the slab.

d. A 15 foot {4.5 m} (min.) straightedge and such other equipment as may be necessary to insure that the jacked slabs meet the alignment and surface requirements.

e. Blow pipe to enlarge void area.

f. Equipment for accurately measuring and proportioning by volume or weight {mass} the various materials composing the grout. When volume is used, the weight per cubic foot {mass per cubic meter} of the materials will be determined and mix proportions adjusted accordingly.

g. A batch type mixer, capable of thoroughly mixing the various components of the grout. A high speed, colloidal type mixer will be required for grout mixes containing only cement and fly ash.

h. A positive action pump capable of forcing grout through a drilled hole into voids and cavities beneath the pavement slab. The pump shall be capable of supplying adequate pressure at the end of the discharge pipe to insure filling of all voids at the required hole spacing. A gage shall be located on the discharge side of the pump to measure the pumping pressure.

i. A flow cone with all necessary components so that the Engineer may make an accurate field determination of the consistency of the grout. The flow cone shall conform to the dimensions and other requirements of U.S. Army Corps of Engineers' Test Method No. CRD-C79-58.

(b) Jacking of Pavement Slabs.

1. Weather Limitations.

Unless approved otherwise by the Engineer in writing, all slabjacking shall be performed between the dates of April 1 and November 1.

Slabjacking operations may not be started unless the air temperature, in the shade and away from artificial heat, is at least 35 °F {2 °C} and rising. Slabjacking shall stop if the temperature is 40 °F {4 °C} and falling or when the subgrade contains an abnormal amount of moisture as evidenced by standing water on the pavement or in joints or cracks.

To accelerate setting and provide early strength to mixes utilizing Type I cement, calcium chloride shall be used in the proportions tabulated below for respective temperature ranges.

Atmospheric Temperature	% Calcium Chloride by Weight {Mass} Of Type I Cement
35 – 55 °F {2 - 12 °C}	5
56 – 69 °F {13 - 20 °C}	4
70 – 79 °F {21 - 26 °C}	3
80 – 89 °F {27 - 31 °C}	2
90 °F {32 °C} and above	1

When Type III cement is used, 0-2 % calcium chloride may be required as needed to accelerate setting in cold weather.

2. Preparation of Grout Mixture.

The mixtures used in slabjacking shall consist of the proportions tabulated in Table I. The consistency may be varied by the addition of water and/or other additives. The quantity by weight {mass} of equivalent 100 % pure calcium chloride to be included in the mixture shall be in accordance with Item 1 above. The calcium chloride, when required, shall be thoroughly pre-mixed in the approximate quantity of mixing water required for a pre-determined batch size before combining with the other ingredients. The consistency of the grout shall be determined by the U.S. Army Corps of Engineers' Test Method No. CRD-C79-58. The quantity of mixing water used shall be that which will produce a grout of such consistency that the time of efflux from the flow cone will be a minimum of eighteen seconds and a maximum of twenty-five seconds for slabjacking. After the initial introduction of a sufficient amount of water into the mixture to obtain the necessary consistency, no additional water shall be added. The grout shall be used within one and one-half hours after introduction of water into the mixture.

Dry ingredients may be added to a mixed batch only in the amounts necessary to bring a too thin mixture to the required consistency. In this case the added dry ingredients shall be in the specified ratio. Grout which fails to meet the flow requirements specified above shall not be used in jacking operations.

A grout mixture shall be selected by the Contractor from the mixtures shown in Table I below. The Engineer reserves the right to specify a different mixture if the one chosen by the Contractor fails to produce the desired results.

TABLE I GROUT MIXTURES MIX PROPORTIONS PERCENT BY VOLUME OF DRY INGREDIENTS						
	GROUT TYPE					
	1	2	3	4	5	6
Fine Sand				30	50	50
Limestone Dust		50	80			30
Fly Ash	80	30		50	30	
Cement	20	20	20	20	20	20

3. Construction.

a. General.

Except as specifically outlined in these specifications, the techniques involved in the slabjacking operation shall be the option of the Contractor as long as the desired results are achieved.

Hole drilling patterns for pavement jacking shall be determined by the Contractor in the field based on conditions such as the size or length of the pavement area to be raised, the elevation difference, subgrade and drainage conditions, location of joints and cracks, and similar local circumstances. Extra holes may be required during the jacking process to apply additional pressure in a local area.

Holes may be washed with water or blown with air to create a small hole from which the grout slurry can then spread. The injection holes shall be drilled through treated base so the base may be lifted with the pavement.

Before slabjacking begins at a location, the Engineer will furnish the Contractor with the profile grade to be attained along with a nearby referenced point of elevation. The Contractor shall pump in a pattern and in the amount required to raise the pavement to within 1/4 of an inch {6 mm} of the designated grade.

b. Jacking.

During the jacking operation, the discharge end of the grouting apparatus shall not extend below the lower surface of the concrete pavement. Continuous pressures up to 200 psi {1.5 Mpa} will be permitted. Pressures to 300 psi {2.0 Mpa} will be allowed only for short periods. If the pavement is bonded to the subgrade, brief bursts of pressure to 600 psi {4.0 Mpa} will be allowed.

After slabjacking has been completed in a hole and the discharge pipe removed, the hole shall be plugged immediately with wooden plugs tapered to fit in the hole to retain the pressure of the grout and stop any waste or return flow of the mixture. When slabjacking to the desired elevation has been accomplished, the temporary plugs shall be removed and the hole filled with an approved stiff cement grout or concrete mixture.

Unless approved otherwise by the Engineer, slabjacking operations shall cease as early as necessary to permit the grout to harden at least three hours prior to allowing traffic back on the grouted slab before first darkness.

Lifting shall be done using sufficiently sized increments and change in injection locations to keep slab stresses to a minimum and to avoid cracking. Slabs which, in the opinion of the Engineer, have been damaged by the Contractor's operation or lack of control such that their repair or replacement is necessitated shall be repaired or removed and replaced at no cost to the Department.

c. Overjacking.

Any part of the pavement raised above the tolerances listed in Subitem 452.03(b)3.a. above shall, if so directed by the Engineer, be brought to grade by grinding. Should the overjacking be greater than 0.1 foot {30 mm}, the Department at its option may require removal and replacement of the pavement without cost to the Department and to its satisfaction with regard to area involved, method and time of replacement, and materials involved.

d. Radial Cracks.

Cracks emanating radially from the grout injection holes will be presumed to have been caused by improper injection techniques by the Contractor. For each 5 feet {1.5 m} of such crack measured, the Contractor's pay quantity shall be reduced by 0.25 bag of cement.

e. Unanticipated and Changed Conditions.

Should the Engineer deem that continued grout injection at any specific location is no longer economically feasible, he may direct the Contractor to cease grout injection at that location. The Contractor will be paid at the unit bid price for the material used up to that point. The Engineer, at his discretion, may delete any location or may add a new location to be raised. Due to unknown conditions and the experimental nature of this type work, variations of any size in the plan quantity will not be considered cause for any increase or decrease in the unit contract bid price.

452.04 Surface Requirements.

After the slabjacking has been completed at a location, and before cleaning and sealing of cracks, the pavement surface shall be tested with a 15 foot {4.5 m} straightedge placed on the surface parallel to the centerline of the lane at points as directed across the width of the pavement and lapping 1/2 the length of the straightedge progressing longitudinally along the pavement or with an approved rolling straightedge. The Contractor shall furnish the straightedge and personnel to operate it under the direction of the Engineer. Areas showing high spots of more than 1/4 of an inch {6 mm}, but less than 1/2 of an inch {13 mm}, under the 15 foot {4.5 m} straightedge shall be ground down with approved grinding equipment until the high spot is less than 1/4 of an inch {6 mm} high. If the area is more than 1/4 of an inch {6 mm} low or 1/2 of an inch {13 mm} high under the 15 foot {4.5 m} straightedge, the pavement in the affected area shall be repaired to the Engineer's satisfaction without additional compensation; such repair may require removal and replacement of the affected area. Any area so removed shall not be less than 8 feet {2.5 m} in length nor less than the full width of the lane involved. If the area to be removed extends to a point less than 8 feet {2.5 m} from a joint, it shall be extended to the joint.

452.05 Opening To Traffic.

Unless specifically authorized otherwise, no traffic, including construction equipment, will be permitted on the jacked slabs until at least three hours after the grouting has ceased. When Type III cement is used, traffic will be prohibited until initial set occurs. Initial set shall be defined as 800 psi {5.5 MPa} when tested in accordance with AASHTO T 197.

Slabs that have been removed shall be replaced the same day they are removed. No traffic, including construction equipment, will be permitted on the replaced slab until at least six hours after the slab has been poured.

Traffic shall be placed on grouted slabs before first darkness of the same day that the slabs were grouted; traffic shall be placed on replaced slabs no later than the morning following the day the slabs were replaced.

452.06 Method of Measurement.

Portland cement pressure grout for slabjacking will be measured for payment by the bag (94 pounds {42 kg}) of Portland cement used in the grout; all other ingredients required in the grout will not be measured for payment.

No other work under this Section will be measured for payment; this includes all hole drilling and any slab repair, removal, replacement, or grinding which may become necessary due to the slabjacking operation.

452.07 Basis of Payment.

(a) Unit Price Coverage.

Portland cement pressure grout for slabjacking, measured as noted above, will be paid for at the contract unit price bid per bag of cement used in the grout. This price shall be full compensation for furnishing of the grout, including all ingredients for the type mix designated, for mixing, for pumping of the grout, for all holes drilled, for any and all slab repair, removal, replacement, or grinding, and all equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

452-A Portland Cement Pressure Grout for Slabjacking - per bag

SECTION 453
PRESSURE GROUTING AND REPAIR OF PORTLAND CEMENT CONCRETE PAVEMENT

453.01 Description.

The work covered by this Section consists of the stabilization of existing unstable concrete pavement slabs by pressure pumping of a specified grout under the slabs along with the removal and replacement of designated shattered paving slabs or sections of slabs. The word slab in this Section shall mean not only a slab, or a portion of a slab, in a jointed concrete pavement system, but also a portion of a continuously reinforced concrete pavement.

Pressure pumping of grout or subsealing of the pavement slabs is intended to stabilize the slab by filling voids and cavities under the slabs with a grout mixture that will form a hard insoluble mass.

Removal and replacement of concrete pavement shall be as directed by the Engineer.

Cracking in concrete pavement is defined as follows:

Hairline cracks - Small, tight cracks which in width resemble shrinkage cracks. No corrective repair procedure is required.

Low severity cracks - Wider than hairline cracks with the crack opening clearly visible. The concrete on both sides of the crack is acting with interlock between the cracked pieces limiting movement of the individual pieces.

Medium severity cracks - The concrete on both sides of the crack is acting with partial interlock between the cracked pieces allowing potential or actual small movement of the individual pieces.

High severity cracks - The concrete on both sides of the crack is acting independently allowing unrestricted movement of the individual pieces.

If the crack does not have the same severity level along the entire length, the crack will be rated as the highest severity level present.

Appropriate repair procedures for the various types of cracked slabs in a jointed pavement are as follows:

Low severity cracking will not require the removal of pavement. These cracks will be routed and sealed under Item 454-A.

Medium severity cracking will require the removal and replacement of at least a portion of the concrete slab. The entire slab is to be removed and replaced if broken into four or more pieces by at least medium severity cracks.

High severity cracking will require the removal and replacement of at least a portion of the concrete slab. The entire slab is to be removed and replaced if it is broken into three or more pieces of high severity cracks.

Due to the variations in quantities that can be experienced in this type work, the quantities for the items in this Section cannot be accurately determined before the work is done; therefore, the items in this Section shall be excluded from those items which may have their unit price adjusted as allowed by Subarticle 104.02(a). At any time during the life of the project, should any process or work herein be deemed ineffective or unnecessary by the Engineer, the Engineer may order any and/or all work under this Section stopped, reduced, and/or eliminated. In such case, the Contractor will be paid for all work ordered and performed. No claim will be considered because of elimination or reduction of work under this Section.

453.02 Materials.

(a) General.

Materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, and the requirements noted in this Article.

(b) Grout.

The grout used in pressure grouting shall consist of one of the mixtures shown in Table I with the materials complying with the following:

Type I or III Cement - Articles 815.01 and 815.03

Calcium Chloride - Section 805 Type I

Fly Ash- Section 806 modified to waive the Loss on Ignition requirement

Water - Section 807
Admixtures - Section 808 and 809
Limestone Dust - Limestone dust shall be thoroughly dry, free of lumps, meeting the following gradation requirements:

Size	% Passing by Weight {Mass}
No. 30 {600 µm} Sieve	100
No. 100 {150 µm} Sieve	90 - 100
No. 200 {75 µm} Sieve	65 - 100

Fine Sand

Fine sand shall comply with the appropriate requirements of Section 802 allowing the use of manufactured sand from limestone, sandstone or granite, or natural silica fine sand meeting the following gradation requirements:

Size	% Passing by Weight {Mass}
No. 10 {2.00 mm} Sieve	95 - 100
No. 60 {250 µm} Sieve	40 - 90
No. 200 {75 µm} Sieve	0 - 50
Percent Silt	0 - 25
Percent Clay	0 - 12
Percent Organic Material	0 - 3

Sand shall be non-plastic as determined by AASHTO T 89 and T 90.

(c) Concrete.

Concrete for Portland Cement concrete pavement replacement shall meet the requirements of Section 450 utilizing either Type III cement or Type I cement containing a non-chloride accelerator. The use of an accelerator will not be required when the ambient air temperature is above 85 °F {29 °C}.

(d) Adhesives.

Adhesives furnished for anchoring tie bars and dowel bars shall meet the requirements of Article 870.04.

453.03 Construction Requirements.

(a) Equipment.

1. Equipment for Pressure Grouting.

The equipment for pressure grouting of concrete pavement shall be that customarily used in the pressure grouting of earthen embankments or in mud-jacking of concrete pavement consisting of at least the following:

a. Air compressors of sufficient capacity for operating pneumatic hammers.

b. A discharge pipe with an adequate securing device.

c. Pneumatic hammers equipped with drills that will cut 1.5 inch {38 mm} diameter or other approved diameter holes through the rigid pavement. The equipment shall be operated in such a manner so as to prevent unnecessary damage to the slab.

d. A portable gage apparatus which operates from the shoulder and is capable of monitoring slab movement during grouting of holes near the pavement edge. Dial gages with at least 1 inch {25 mm} of travel arm and capable of detecting 0.001 of an inch {25 µm} of movement shall be placed within 1 foot {300 mm} of the hole being grouted and 1 foot {300 mm} outside the edge of paving. The dial gage measuring movement within 1 foot {300 mm} of the hole being grouted shall have an arm length of at least 6 feet {1.8 m}. The base of the support for the gage apparatus shall be a minimum of 5 feet {1.5 m} outside the edge of paving during the monitoring of movement and shall be moved along the shoulder during the grouting of holes along the

pavement edge. An engineer's level, furnished and operated by the Department, will be used, periodically throughout the day, to supplement the gage apparatus to monitor slab movement.

Alternate gage apparatus setups may be used if requested in writing by the Contractor and approved by the Engineer.

e. Blow pipe to enlarge void area.

f. Equipment for accurately measuring and proportioning by volume or weight {mass} the various materials composing the grout. When volume is used, the weight per cubic foot {mass per cubic meter} of the materials will be determined and mix proportions adjusted accordingly.

g. A batch type mixer, capable of thoroughly mixing the various components of the grout. A high speed, colloidal type mixer will be required for grout mixes containing only cement and fly ash.

h. A positive action pump capable of forcing grout through a drilled hole into voids and cavities beneath the pavement slab. The pump shall be capable of supplying adequate pressure at the end of the discharge pipe to insure filling of all voids at the required hole spacing. A gage shall be located on the discharge side of the pump to measure the pumping pressure.

i. A flow cone with all necessary components so that the Engineer may make an accurate field determination of the consistency of the grout. The flow cone shall conform to the dimensions and other requirements of ALDOT-338.

2. Equipment for Removal and Replacement.

The equipment for removal and replacement of the concrete pavement slabs shall be suitable for the purpose intended and approved by the Engineer. Attention is directed to the operational requirements for removal and replacement in Subarticle (c) below.

(b) Pressure Grouting of Pavement Slabs.

1. Weather Limitations.

Unless approved otherwise by the Engineer in writing, all pressure grouting shall be performed between the dates of April 1 and November 1.

Pressure grouting operations may not be started unless the air temperature, in the shade and away from artificial heat, is at least 35 °F {2 °C} and rising. Pressure grouting shall stop if the temperature is 40 °F {4 °C} and falling or when the subgrade contains an abnormal amount of moisture as evidenced by standing water on the pavement or in joints or cracks.

To accelerate setting and provide early strength to mixes utilizing Type I cement, calcium chloride shall be used in the proportions tabulated below for respective temperature ranges. Normal traffic flow may be resumed three hours after grouting.

Atmospheric Temperature	% Calcium Chloride by Weight {Mass} Of Type I Cement
35 – 55 °F {2 - 12 °C}	5
56 – 69 °F {13 - 20 °C}	4
70 – 79 °F {21 - 26 °C}	3
80 – 89 °F {27 - 31 °C}	2
90 °F {32 °C} and above	1

When Type III cement is used, 0-2% calcium chloride may be required as needed to accelerate setting in cold weather. Grouted slabs may be opened to traffic in accordance with Subarticle 453.03(d).

2. Preparation of Grout Mixture.

The mixtures used in pressure grouting shall consist of the proportions tabulated in Table I. The consistency may be varied by the addition of water and/or other additives. The quantity by weight {mass} of equivalent 100% pure calcium chloride to be included in the mixture shall be in accordance with Item 1 above. The calcium chloride, when required, shall be thoroughly pre-mixed in the approximate quantity of mixing water required for a predetermined batch size before combining with the other ingredients. The consistency of the grout shall be determined in accordance with ALDOT-338. The quantity of mixing water used shall be that which will produce a grout of such consistency that the time of efflux from the flow cone will be a minimum of 14 seconds and a maximum of 22 seconds for undersealing. After the initial introduction of a sufficient amount of water into the mixture to obtain the necessary consistency, no additional water shall be added. The grout shall be used within 90 minutes after introduction of water into the mixture.

Dry ingredients may be added to a mixed batch only in the amounts necessary to bring a too thin mixture to the required consistency. In this case the added dry ingredients shall be in the specified ratio. Grout which fails to meet the flow requirements specified above shall not be used in grouting operations.

A grout mixture shall be selected by the Contractor from the mixtures shown in Table I below. The Engineer reserves the right to specify a different mixture if the one chosen by the Contractor fails to produce the desired results.

TABLE I
GROUT MIXTURES

	Mix Proportions, Percent by Volume of Dry Ingredients					
	Grout Type					
	1	2	3	4	5	6
Fine Sand				30	50	50
Limestone Dust		50	80			30
Fly Ash	80	30		50	30	
Cement	20	20	20	20	20	20

3. Construction.

Selected slabs designated by the Department for pressure grouting shall be drilled as indicated on the plans or designated by the Engineer. For holes nearest the edges of the slab, the joints, or a major crack, a maximum of 3 inches {75 mm} from the precise marked location is considered to be reasonable. For other holes, a maximum 6 inch {150 mm} tolerance is considered to be reasonable. Should it become necessary or desirable to drill holes at locations other than those shown on the plans, such holes shall be drilled only as approved by the Engineer. In no instance shall holes be drilled in the wheel paths of a lane. The drills shall be rotated to avoid cracking the pavement and to provide satisfactory holes of the proper diameter for effective operations in pressure grouting. When drilling holes, the drills shall be held as nearly perpendicular to the pavement surface as possible. Holes which cannot be satisfactorily used in pressure grouting shall be filled with grout and not measured for pay; new holes shall be drilled.

After the holes are drilled, and just prior to pressure grouting, a high pressure air pipe may be required to clean the hole, if deemed necessary by the Engineer, to facilitate introduction of the grout.

After the holes are cleaned, the discharge hose on the pressure grout pump shall be connected to the hole in a manner that will provide adequate seal to maintain pressure past the connection. The discharge end of the pipe shall not extend below the lower surface of the concrete pavement.

To fill all voids, pumping of grout will be required in holes designated by the Engineer. The maximum pressure allowed during the grouting operation will be 200 psi {1.5 Mpa}. A gage shall be located on the discharge side of the pump to measure the pumping pressure. Normally, indication that grout is flowing out of an adjacent hole or joint or the edge of the slab is sufficient evidence that all cavities or voids are filled within the range of the hole being grouted and pumping in such hole shall cease. Additional evidence that grouting should cease is a rapid rise of the slab, or indications of a rise of the adjacent shoulder. A minimal lifting of the slab will be allowed but not to exceed 0.05 of an inch {1 mm} per grouting pass. Care shall be taken not to crack slabs by differential lifting. Any slab or portion of slab or shoulder which is raised more than 0.05 of an inch {1 mm} each grouting will require corrective action, without payment, by the Contractor. Such corrective action shall consist of grinding or other methods approved by the Engineer.

After grouting has been completed in a drill hole, the discharge pipe shall be withdrawn and latent grout removed. The hole shall not be plugged unless authorized otherwise by the Construction Engineer. Patching of the hole shall begin after the grout has taken an initial set. The grout shall be removed to a minimum depth of 4 inches {100 mm} below the pavement surface. A low slump concrete mix consisting of 1-part Type I or Type III cement and 2-parts No. 100 concrete sand by volume shall then be placed in the hole, rodded and leveled with the pavement surface. Filled holes that later shrink below the finished surface, ravel out, or otherwise become damaged before project completion shall be repaired.

Corrective measures shall be taken in case stooling occurs by making proper adjustment in the stiffness of the grout being used. In case stooling does occur, additional holes shall be provided as

directed and a more fluid grout shall be pumped through these new holes to fill the voids between the stools.

At least 24 hours, but no later than 5 days, after a slab has been grouted, it shall be tested for movement between the hours of 3:00 a.m. and 7:00 a.m. On cool, cloudy days, this time frame may be extended if approved by the Engineer. The test rolling equipment shall be rubber-tired and of sufficient weight {mass} to give a 20,000 pounds {90 kN} single axle load with a minimum of 10,000 pounds {45 kN} per side (a properly loaded dump truck may be used).

Each slab shall be tested by making one or more passes over it with the test roller. The rolling shall be slow enough to allow an observer to measure the movement and mark the slab if regrouting is needed. If the slab moves 0.03 of an inch {0.8 mm} or more during the test rolling, new holes shall be drilled and the slab regrouted. All slabs which have been regrouted shall be retested as outlined above for the initial testing.

After two returns for regrouting, should the slab fail the test rolling, the Engineer will make the decision to leave the slab as is, continue regrouting, or remove and replace the slab. Payment will be made under the appropriate pay items for the additional drill holes and grout used in the regrouting operation. The cost of test rolling shall be absorbed in other items of work.

The construction methods outlined above may be modified by the Engineer as field conditions indicate.

Pressure grouting operations shall cease at least three hours before sundown, except that on cloudy days pressure grouting operations shall cease earlier as necessary to permit grout to harden at least three hours prior to allowing traffic back on the grouted slab before first darkness. First darkness shall be defined as that time of day the average traveling public vehicle would first begin to use its headlights.

(c) Removal and Replacement of Pavement Slabs.

1. Removal.

The extent of removal shall be as shown on the plans or directed by the Engineer. The slab section designated for removal shall be sawed as shown on the plans. The Contractor shall not oversaw the slab within 2 feet {600 mm} of another oversaw or within 2 feet {600 mm} of any type of joint. Transverse cuts for removal and the placing of new steel tie bars shall be performed as shown by plan details. The sections of pavement to be removed may be removed in any manner approved by the Engineer which does not damage the underlying base layer, adjacent concrete slabs, or the joint steel. Any damage to the underlying base or adjacent slabs shall be repaired to the satisfaction of the Engineer. Joint steel shall be cleaned and reconditioned to provide the same load transfer and/or tie as in the original pavement design. Any damaged or destroyed steel, which in the opinion of the Engineer would not function properly, shall be replaced in kind and retied to the old pavement by drilling an appropriate size hole of the proper depth and anchoring the new bar with an approved adhesive material. This replacement also includes steel damaged or destroyed previous to the removal operation. All tie bars and dowel bars tied to the old pavement shall be anchored into place with an approved adhesive material in such a manner as to meet a 7200 pound {32 kN}, minimum, pull-out requirement. The Department will perform the pull-out tests in accordance with ALDOT-366. The Contractor shall supply the equipment necessary to perform the pull-out test.

Slabs shall be removed and replaced during the same day. Preparation for removal, including sawing the slab into smaller pieces, may be done the day prior to removal, but traffic shall be maintained on the slab the night before removal.

2. Concrete Pavement Replacement.

After completion of removal operation, the joint steel and/or reinforcing steel shall be reconditioned or replaced (reconditioned means the cleaning and straightening of the steel bars and the cleaning, painting, greasing, replacement, etc. of the dowels), new tie bars placed as detailed by the plans, and the base cleaned and repaired as directed, and then the slab shall be poured.

The Contractor shall provide gang drills or templates that will provide the proper alignment for holes drilled for dowels or tie bars. The size of the drilled hole shall be 1/8 of an inch {3 mm} greater in diameter than the diameter of the dowel or tie bar being installed therein. The drill used shall not cause any spalling of the existing concrete around the face of the drill hole.

The Contractor shall provide a device that will place the adhesive in the back of the drilled hole first and then proceed toward the front. After the dowels or tie bars are anchored in place, the Contractor shall allow time for the adhesive to set and then allow sufficient time for any required pull-out tests to be performed prior to pouring the replacement slab.

The concrete paving slab shall be poured in accordance with the provisions of Section 450 except that Structural Portland Cement Concrete meeting the requirements of Section 501 for a Class A concrete utilizing either Type III cement or Type I cement with a non-chloride accelerator, shall be used and a full paving train will not be required. Unless shown otherwise by the plans, the surface finish and slope of the new pavement shall be the same as the adjoining pavement slabs. If the pavement is to be covered by a bituminous overlay, a wood float finish and straight slope will be acceptable. All joints, except expansion joints, with adjacent pavement shall be butt type tied construction joints. Expansion joints shall be reconstructed so that the continuity of existing expansion joints are retained utilizing similar joint filler and sealed with the type sealer specified on the plans. Other reconstructed joints which require sealing shall be sealed with the specified type sealer. When a joint is completely removed, new materials shall be used throughout the joint. All materials necessary to repair or reconstruct the joints in or adjacent to the concrete pavement replacement is considered incidental to said replacement.

All joints shall be constructed in accordance with the provisions of Subarticle 450.03(j) except as noted herein. Due to the requirement for the use of either an accelerator or Type III cement in the concrete mix, extreme care shall be taken to see that joints are saw cut before uncontrolled shrinkage cracking begins.

Slabs that have been removed shall be replaced the same day they are removed.

The Contractor shall use such approved methods as necessary to keep all pavement surfaces adjacent to this operation reasonably clean of excess grout or other materials at all times.

(d) Opening to Traffic.

No traffic, including construction equipment, will be permitted on the grouted slabs until at least three hours after the grouting has been completed.

No traffic, including construction equipment will be permitted on the replaced slab until at least six hours after the slab has been poured.

Traffic shall be placed on grouted slabs before first darkness of the same day that the slabs were grouted; traffic shall be placed on replaced slabs no later than the morning following the day the slabs were replaced.

453.04 Method of Measurement.

Each drill hole through the concrete paving slab ordered by the Engineer and placed in accordance with the requirements noted herein in this Section and properly filled after satisfactory use will be measured for payment.

Portland cement concrete grout will be measured for payment by the bag (94 pounds {42 kg}) of Portland cement used in the grout; all other ingredients required in the grout will not be measured for payment.

Concrete pavement removed will be measured in square yards {square meters} computed from surface measurements taken to the nearest 0.1 foot {0.1 meter}.

Concrete pavement replacement slabs will be measured by computing the theoretical cubic yards {cubic meters} of concrete necessary to replace the removed slab. The thickness used in computing the theoretical cubic yards {cubic meters} will be the average thickness necessary to replace the slab and to fill any voids, except those caused by the Contractor, underneath the slab.

453.05 Basis of Payment.

(a) Unit Price Coverage.

1. Drill Holes.

Drill holes for stabilizing the concrete pavement, measured as noted above, will be paid for at the contract unit price bid per each which shall be full compensation for the drilling of the holes and the sealing of the holes after the satisfactory use thereof, and includes the furnishing of equipment, tools, labor, and incidentals necessary to complete this item of work.

2. Portland Cement Pressure Grout.

Portland cement pressure grout, measured as noted above, will be paid for at the contract unit price bid per bag of cement used in the grout, which shall be full compensation for furnishing the grout, including all ingredients for the type mix designated, for the mixing, for pumping of the grout, and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

3. Removal of Concrete Pavement Slabs.

Removal of concrete pavement slabs, measured as noted above, will be paid for at the contract unit price bid per square yard {square meter}, which shall be full compensation for the sawing and satisfactory removal and disposal of the old concrete, for the reconditioning or replacement of all steel and the concrete joint including all equipment, tools, labor, and other incidentals necessary to complete this item of work.

4. Concrete Pavement Replacement Slabs.

Concrete pavement replacement slabs, measured as noted above, will be paid for at the contract unit price bid per cubic yard {cubic meter} which shall be full compensation for the furnishing of the concrete mix, the hauling of the mix, the forming, placing, including any new steel, sawing and sealing of joints, finishing and curing of the slab and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

5. Smoothness Acceptance.

After the grouting operation, all surfaces shall receive grinding in accordance with Section 455 and shall meet the smoothness requirements of Subarticle 455.03e.

(b) Payment will be made under Item No.:

453-A Drill Holes (Max. bid limited to $6.00 per Hole) - per each
453-B Portland Cement Pressure Grout - per bag (94 pounds {42 kg})
453-C Removal of Concrete Pavement Slab - per square yard {square meter}
453-D Concrete Pavement Replacement Slab - per cubic yard {cubic meter}

SECTION 454
CLEANING AND SEALING JOINTS AND CRACKS IN CONCRETE PAVEMENT

454.01 Description.

This Section shall cover the work of cleaning and sealing joints and cracks in existing concrete pavement. The shape of the joints shall be restored by sawing the concrete to allow the proper sealing of the joints. Cracks shall be sealed by the routing of a groove at the crack for the placement of sealant.

The cleaning and sealing of joints and cracks will be classified by "Type" in accordance with the following:

Type I: Cleaning and sealing of joints and cracks that will not be covered by a bituminous overlay.
Type II: Cleaning and sealing of joints and cracks that will be covered by a bituminous overlay.

454.02 Materials.

The sealant shall be either a Hot Applied Joint Sealant or a Cold Applied Joint Sealant as shown on the plans. Joint sealants shall meet the requirements given in Section 832 for joint and crack sealants.

454.03 Construction Requirements.

(a) Submittal of Equipment Data.

The Contractor shall submit descriptions of all equipment proposed for use in sawing the joints, routing the cracks, cleaning the joints and cracks and placing the sealant. The submittal shall also consist of the operational guidelines from the equipment manufacturer. The Contractor shall deliver the submittal to the Engineer for review. The Engineer will not approve the submittal but will review it for completeness. The Engineer will prohibit the use of equipment that may damage the pavement or result in a joint or crack that cannot be sealed. Equipment shall not be brought to the worksite until the Engineer informs the Contractor that the submittal is complete.

(b) Preparation of Joints for Sealant.

The old joint sealant material and other debris shall be removed from the joint. Material placed to form an expansion joint during the original construction of the pavement shall not be removed.

The joint shall then be cut with a concrete saw to provide the shape and size of joint shown on the plans. The concrete saw shall be a saw that is designed for cutting concrete. If water is used to facilitate cutting, the resulting slurry shall be completely removed from the joint and the pavement

surfaces before it dries. Removal of the slurry shall be by flushing the joint and pavement surface with a jet of water under pressure and by the use of other tools as required by the Engineer.

After the sawing, and flushing if necessary, the joint shall then be cleaned of loose material by the use of compressed air.

If further cleaning is required prior to sealing, one or more of the following cleaning methods shall be used:

Wire Brush and Muriatic Acid: The joints shall be thoroughly cleaned with a mechanical wire brush and other tools as necessary. All harmful materials such as oil, asphalt, curing compound, paint, rust and other debris shall be completely removed. After brushing, a solution of 10 % commercial muriatic acid shall be applied to the surfaces of the joint. After the foaming action of the acid has ceased, the joint shall be thoroughly flushed with water and thoroughly brushed again. After flushing and rebrushing, the joint shall be blown out with compressed air.

Sand Blasting: The joints shall be thoroughly cleaned with a sand blaster and other tools as necessary. All material such as oil, asphalt, curing compound, paint, rust and other debris shall be completely removed. After blasting, the joint shall be blown out with compressed air.

High Pressure Water Jet: The joints shall be thoroughly cleaned of all debris including old sealant.

Air compressors used for cleaning joints shall be equipped with traps and filters capable of removing water and oil in the compressed air. This compressed air will be checked by the Engineer for contamination. The air compressor shall be replaced if the air contains water or oil.

(c) Preparation of Cracks for Sealant.

Cracks shall be prepared for sealant by the cutting of a groove in the concrete with a rotary router. The groove shall be cut along the centerline of the crack to the shape and size shown on the plans. After the crack has been routed, it shall be cleaned and dried using the same procedures that are required for cleaning and drying joints.

(d) Sealing of Joints and Cracks.

Surfaces shall be clean and dry before the placement of the sealant. Immediately before the joint sealant is placed compressed air having a pressure of at least 90 psi {600 kPA} shall be used to blow out the joint and remove all traces of dust.

If a primer is recommended by the manufacturer of the sealant, it shall be used in accordance with the manufacturer's recommendations.

The sealant shall not be placed when the air temperature is less than 50 °F {10 °C} or is 50 °F {10 °C} and falling, unless allowed by the Engineer.

The sealant may be applied by a mechanical device or by manual pouring or trowelling, unless recommended otherwise by the manufacturer. When applied mechanically or by pouring, a nozzle or pouring spout shall be shaped to fit inside the joint or crack to introduce the sealant from inside the joint or groove.

After a joint or crack has been sealed, all surplus primer or sealant on the pavement surfaces shall be promptly removed.

Traffic shall not be permitted over sealed joints or cracks until the sealant is tack free.

In addition, the sealant shall be placed and worked to provide the shape of sealed joint or crack shown on the plans.

(e) Spalls.

Spalls adjacent to joints and cracks that are smaller than 3 square inches {2000 mm^2} measured across the surface of the pavement shall be cleaned with the cleaning of the joint or crack. The spall shall then be filled with sealant when the sealant is placed in the joint or crack. (The full depth of the slab may be designated for replacement in accordance with the requirements given in Section 453 where the spall is larger than 3 square inches {2000 mm^2}.)

454.04 Method of Measurement.

The cleaning and sealing of concrete pavement joints and cracks will be measured in linear feet {meters} of joint or crack length, to the nearest 0.1 foot {0.1 m}, along the surface of the pavement.

454.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for cleaning and sealing concrete pavement joints and cracks shall be full compensation for sawing the joints, routing the cracks, furnishing all materials, equipment, tools, labor, and incidentals necessary to clean and seal all designated concrete pavement joints and cracks.

(b) Payment will be made under Item No.:

454-A Cleaning and Sealing Concrete Pavement, Type _*_ _**_ - per linear foot {meter}

* Specify I or II

** Specify Joints or Cracks

SECTION 455
GRINDING CONCRETE PAVEMENT SURFACES

455.01 Description.

This Section shall cover the work of grinding Portland Cement Concrete pavement at locations shown on the plans or directed by the Engineer. The primary locations will be the right-hand lane, or truck lane, of each roadway, but may include other locations.

Said grinding is intended to substantially correct joint faulting, surface drainage, skid resistance, riding characteristics and/or removal of excessive surface material.

455.02 Materials.

N/A

455.03 Construction Requirements.

(a) General.

It is intended that areas of the pavement surface designated by the plans or Engineer to be processed shall be ground to eliminate joint or crack faults and to provide a constant pavement cross slope within the designated grinding limits in each lane. Adjacent sides of longitudinal joints or crack shall be in the same plane. Adjacent sides of transverse joints or cracks in excess of 1/16 of an inch {2 mm} shall be reground until flush.

If a progress schedule for the grinding operation is not shown on the plans, the Contractor may select his own grinding operation schedule. The grinding operation shall be expeditiously performed in a continuous operation on a traffic lane before grinding begins on a succeeding lane.

The residue created by the grinding operation shall be satisfactorily removed as the grinding operation proceeds.

(b) Equipment.

Grinding equipment shall be a self-propelled unit specifically designed to grind Portland Cement concrete pavement using diamond grinding blades capable of grinding the designated surfaces without causing spalls at cracks or joints or at other locations. The equipment shall be of a size, shape and dimension capable of working within the designated work limits without restricting the movement of traffic outside of the work limits.

The Contractor shall provide positive means for the removal of the grinding residue before such residue is blown by traffic action or wind. Residue shall not be permitted to flow across lanes designated for traffic use or into gutters or other drainage structures.

(c) Operational Requirements.

1. General.

It is the intent that the work of grinding of the pavement surface be performed under traffic. Traffic may be shifted to one lane on a 4-lane facility; but no consideration will be given to transferring traffic to one travelway during this operation.

The area of pavement surfaces to be ground will be designated on the plans, unless directed otherwise by the Engineer.

The construction operations shall be scheduled and prosecuted in such a manner that a uniform surface finish which eliminates the joint or crack faults while maintaining positive lateral drainage by maintaining a constant cross slope is obtained.

2. Main Roadway.

All preliminary work of stabilizing and repair on the main roadway shall be completed prior to commencing grinding operations. This preliminary work includes the stabilization of designated pavement slabs and removal and replacement of certain slab sections as noted by plan details or as directed by the Engineer.

The entire area of the travelway designated to be ground shall be ground until the adjacent sides of joints and cracks are in the same plane, the cross slope complies with typical section shown by plan details and the surface requirements of Subarticle 455.03(d). It is the intent of this specification that the faulting at joints and cracks be eliminated, the overall roughness be within the specified limits and that the pavement surface of the lane designated for treatment be textured.

(d) Final Surface Finish.

The grinding process shall produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. Said line type texture shall consist of parallel longitudinal corrugations of approximately 60 evenly spaced grooves per foot {300 mm} with the ridges approximately 1/32 of an inch {1 mm} higher than the bottom of the grooves.

Joints and cracks shall be visually inspected to insure that adjacent surfaces are in the same plane. Misalignment of the surface planes of adjacent sides of joints or cracks which is in excess of 1/16 of an inch {2 mm} shall be ground until the surfaces are flush.

The transverse slope of the ground pavement shall be uniform to a degree that no depressions or misalignment of slope greater than 1/4 of an inch {6 mm} in 12 feet {3.5 m} are present when tested with a 12 foot {3.5 m} straightedge placed perpendicular to the pavement centerline. Straightedge requirements do not apply outside of the ground areas.

(e) Smoothness Requirements.

1. Application of Smoothness Requirements.

Smoothness requirements shall be applicable to the grinding of the concrete pavement surfaces if Pay Item 455-C Smoothness Testing, Certified Inertial Profiler is included in the contract.

2. Smoothness Testing Procedure.

The smoothness testing procedure shall be ALDOT-448, *Evaluating Pavement Profiles*. This procedure is posted on the ALDOT Internet site in the pages of the Materials and Tests Bureau. The Mean Roughness Index shall be measured after the grinding of the concrete pavement surface.

The results of the smoothness tests will be evaluated by the Engineer.

3. Contract Price Adjustment based on Mean Roughness Index.

Payment for the grinding will be made in accordance with the contract price adjustments given in the following table.

Mean Roughness Index Inches/mile/section {meters/kilometer/section	Contract Price Adjustment, Percent of "Grinding Concrete Pavement" Unit Contract Price
Under 40.0 {Under 0.6}	105
40.0 to less than 65.0 {0.6 to less than 1.0}	105 – [(Mean Roughness Index-40)/5)] {105 – [(Mean Roughness Index- 0.6)/0.08]}
65.0 to less than 95.0 {1.0 to less than 1.5}	100
95 through 145 {1.5 through 2.3}	100 – [(Mean Roughness Index – 95.0)/2.5] {100 – [(Mean Roughness Index – 1.5)/0.04]}
Over 145.0 {Over 2.3}	Unacceptable

455.04 Method of Measurement.

The grinding of pavement ordered and accepted will be measured in square yards {square meters} computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m} on the processed pavement.

Those areas of pavement requiring corrective action due to inappropriate or unacceptable work or negligence on the part of the Contractor will be excluded from measurement for payment.

455.05 Basis of Payment.

(a) Unit Price Coverage.

The grinding of pavement ordered and accepted, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the grinding of the pavement, the removal of grinding residue and the satisfactory disposal thereof, the cleaning of the pavement and for all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment for the grinding will be adjusted in accordance with the requirements for smoothness if Pay Item 455-C, Smoothness Testing, Certified Inertial Profiler is included in the contract.

(b) Payment will be made under Item No.:

455-A Grinding Concrete Pavement - per square yard {square meter}
455-C Smoothness Testing, Certified Inertial Profiler - per each

SECTION 490
BRIDGE DECK THIN POLYMER OVERLAY

490.01 Description.

This Section shall cover the work of applying Thin Polymer Overlays (TPO) and crack sealing to waterproof and provide a skid resistant riding surface.

490.02 Materials.

(a) General.

Materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, and the requirements noted in this Section.

(b) Crack Sealer Material.

The crack sealer material, if needed, shall be specified as shown in plans. The crack sealing material shall be a solvent less Type I Grade 1 epoxy as specified in AASHTO M 235. The crack sealer material shall be used to repair bridge deck cracks by gravity feeding. The crack sealer shall meet the properties in TABLE 490-1.

TABLE 490-1: Properties of Crack Sealer

Property	Requirement*	Test Method
Viscosity poises, max.	7	ASTM D 2556
Tensile Strength, min. psi.	2500	AASHTO M 235
Elongation, % min.	30	AASHTO M 235
Water Absorption, % by wt. max.	1.0	AASHTO M235

*Based on samples cured and tested at 75˚F

(c) Overlay Material.

The overlay material shall be a completely non-porous polymer bridge deck overlay system designed for low temperature applications. The overlay system shall consist of polymer epoxy binder and aggregate. The overlay system shall not contain any fillers or volatile solvents. The overlay system shall meet the properties in TABLE 490-2.

TABLE 490-2: Properties of Overlay System

Property	Requirement*	Test Method
Viscosity poises	7 - 30	ASTM D 2556
Tensile Strength, min. psi.	2500	AASHTO M 235
Elongation, % min.	30	AASHTO M 235
Adhesive Strength, min. psi. @ 24 hours**	250***	ASTM C 1583
Compressive Strength, min. psi. @ 3 hours***	1000	ASTM C 579 Method B
Compressive Strength, min. psi. @ 7 days***	5,000	ASTM C 579 Method B
Water Absorption, % by wt. max.	1.0	AASHTO M 235
Chloride Permeability, max. Coulombs @ 28 days	100	AASHTO T 277

*Based on samples cured and tested at 75˚F
**Or the manufacturers minimum cure time

***Or 100% substrate failure

(d) Aggregate.

All aggregates used shall be 100 percent fractured, non-polishing, and non-friable. Aggregates shall be calcined bauxite. The physical and chemical properties of the aggregate shall meet the requirements in Table 490-3.

Table 490-3: Aggregate Physical and Chemical Requirements		
Property	**Requirement**	**Test Method**
Polish Stone Value	38 min.	AASHTO T 279
Resistance to Degradation	20% max	AASHTO T 96
Moisture Content	0.2% max	AASHTO T 255
Aluminum Oxide	87% min.	ASTM C 25
Aggregate Gradation	**% Passing by Weight**	AASHTO T 27
Sieve Size		
No. 4 (4.75 mm)	100 min.	
No. 6 (3.35 mm)	95 min.	
No. 16 (1.18 mm)	5 max	

(e) Storage and Handling.

The polymer overlay materials shall be transported and handled in accordance with the manufacturer's recommendations. Polymer overlay materials shall be stored at the job site in their original containers, protected from moisture, and maintained at a temperature between 60 to 90°F for a minimum of 24 hours prior to use. All aggregates shall be stored in a dry environment protected from rain, moisture, and contaminants.

(f) Other Requirements.

All requirements listed in this Subarticle shall be submitted to ALDOT no less than 30 days prior to placement of the polymer overlay. The Contractor shall submit a copy of a certified test report with actual test results from an independent laboratory verifying that the materials meet all the requirements specified in Article 490.02 including Tables 490-1, 490-2, and 490-3. The Contractor shall submit a verification test report for each material lot number to be used on ALDOT projects.

The Contractor shall provide the Materials and Tests Engineer with ten years of performance history data from a minimum of three projects where the proposed (TPO) has been used. The performance history shall be from projects located in Alabama. If no ten year performance history data is available from Alabama, then data from any southeastern states with similar climate conditions, such as temperature and humidity as Alabama may be accepted.

490.03 Construction Requirements.

(a) Submittals.

The Contractor shall submit to the Engineer three sets of copies of product data that completely identifies the physical components, and performance characteristics of the overlay system. The submittal shall also include safety data sheets for all materials to be used.

The overlay materials shall not be ordered until the product data has been accepted by the Engineer as providing an adequate description of the overlay system.

The following items shall be included as a part of the product data submittal:

- Material composition (type of polymer, curing agents, coloring additives, etc.)
- Surface preparation (special cleaning requirements, required extent of cleaning, etc.)
- Curing requirements (acceptable ambient temperature range, acceptable level of humidity, etc.)
- Application requirements and, application equipment requirements, etc.

No less than 30 days prior to construction of the polymer overlay, the Contractor shall submit to the Engineer for approval a work plan for constructing the overlay. The work plan shall include, but not be limited to, construction procedures, anticipated schedule for traffic control, patching and crack

repair procedures, overlay placement procedure, and proposed shot blasting procedure. The work plan shall also include all test reports and samples required as per Subarticle 490.02 (f).

(b) Equipment.

The equipment for cleaning the concrete bridge decks shall be recommended by the manufacturer of the overlay system.

The polymer overlay shall be placed using mechanical equipment capable of mixing, metering, and distributing all components of the overlay system in a continuous application as per the polymer overlay manufacturer's specifications. The equipment shall be capable of heating and maintaining the components of the epoxy binder at a constant temperature. The equipment shall be capable of mixing the components of the epoxy binder at a constant ratio and shall be capable of consistent application rates of both the epoxy and the aggregate and have the capability to display and record the application rates of both materials. The use of agricultural type spreaders for the distribution of the aggregates will not be allowed when mechanical continuous application is required.

(c) Surface Preparation.

The entire area of the deck surface shall be cleaned by shot blasting to provide a surface free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint, and all foreign matter.

The contractor shall use the test method described in ASTM C 1583 "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)" to determine the shot blasting procedure. The shot blasting procedure shall consist of size of shot, flow of shot, forward speed, and number of passes of the shot blasting machine necessary to expose the coarse aggregate and provide tensile adhesion strength equal to or greater than 250 psi or a failure area, at a depth of 0.25 in. or more into the concrete deck. A test section of not less than 300 sq. ft. of bridge deck will be used to establish the shot blasting procedure. Three random test sites will be selected within the test section by the Engineer and tested according to ASTM C 1583. The Contractor shall provide all test equipment and perform the tests. If the adhesion strength or failure depth criteria are not met, the Contractor shall adjust the shot blasting procedure and the test section will be re-blasted and re-tested until satisfactory test results are attained. Once an acceptable shot blasting procedure is established it shall be continued for the remainder of the bridge. The Contractor may, with the permission of the Engineer, change the shot blasting procedure or equipment, in which case an additional test section and testing will be required.

Shot blast cleaning shall include the preparation of all bridge deck spall repair areas. The shot blast cleaning of an area of the deck shall be performed within a 24-hour period preceding placement of the overlay. The shot blast cleaned areas shall be protected against contamination prior to placement of the overlay. Contaminated areas and areas exposed more than 24 hours shall be shot blast cleaned again as direct by the Engineer at the Contractor's expense. In areas that the shot blasting equipment cannot reach (i.e., along curbs and median walls), sandblasting will be permitted to an extent satisfactory to the Engineer. This shall be performed prior to the shot blasting whenever applicable and practical.

Immediately before applying the overlay system, all prepared surfaces shall be cleaned with compressed air (or Vacuumed) to remove dust and debris. All surfaces to be overlaid shall be dry.

(d) Repair of Spalls.

The Contractor shall be responsible to repair any spalled areas prior to the placement of the overlay system. The Contractor shall submit a repair procedure to the Engineer for acceptance prior to performing any repair.

(e) Application of Overlay.

Overlay applications consisting of more than 1,000 square yards shall be placed using mechanical equipment capable of continuous application. Manual application will be allowed only when the overlay application consists of less than 1,000 square yards. The polymer overlay shall be placed in two layers of epoxy and aggregate. Both layers shall consist of a layer of epoxy followed with a layer of aggregate. The layer of aggregate shall completely cover the epoxy. The total thickness of the polymer overlay (both layers) shall not be less than ¼ inch nor greater than ½ inch. The application rates of the polymer overlay shall comply with TABLE 490-4.

TABLE 490-4 Application Rates

Layer	Polymer Gallons/100 Square Feet	Aggregate Pounds/Square Yard

1	Not less than 2.5	Not less than 10.0
2	Not less than 5.0	Not less than 14.0

The Contractor shall plan and execute the work in a manner to provide at least eight hours of curing or the minimum cure time recommended by the manufacturer prior to opening the section to traffic. Prior to opening the section to traffic, the Contractor shall perform at least one pull off test per every 200 linear feet of each lane of bridge deck. The Engineer will randomly select the test locations. Pull off tests shall be performed in accordance to the requirements of ASTM C 1583. The Contractor shall provide all testing equipment. Each individual test shall have a minimum adhesive strength of 175 psi when the bond failure is located at the interface of the concrete and the overlay as described in ASTM C 1583. Unacceptable test results will require removal and replacement of the overlay at the Contractors expense.

The thickness of the overlay shall be verified by using the cores obtained from the pull off tests. Areas found to be less than ¼ inch thick shall be re-coated and re-tested at no cost to the Department.

The overlay manufacturer shall have a representative present at the job site at all times during placement of the polymer overlay. The manufacturer's representative shall advice the engineer of any procedure and/or material not meeting specifications. The Engineer will suspend placement of the overlay system based on the advice of the manufacturer's representative or his/her own observations. Work shall not resume until the Engineer is satisfied that appropriate remedial action has been taken by the Contractor.

Polymer overlays shall not be placed when the ambient temperature is below 55°F or above 90°F and when the surface temperature is below 60°F. Placement of overlays will not be permitted when rain is forecast within 24 hours of application.

(f) Performance Guarantee.

The polymer overlay manufacturer shall provide ALDOT with a ten year performance warranty after the application of the overlay is complete. The warranty shall be submitted to the Engineer for review. The overlay will not be accepted, and final payment made until the Contractor is notified in writing by the Engineer that the warranty is acceptable.

The warranty shall include the requirement that the Manufacturer will be fully responsible for all corrective work required due to performance related issues and to restore the overlay to a serviceable condition.

The warranty shall state that the overlay shall be restored to a serviceable condition by the manufacturer within sixty days of notification by ALDOT that corrective work is required.

490.04 Method of Measurement.

(a) Shot Blast Cleaning.

The area of the deck acceptably shot blast cleaned prior to placing the overlay will be measured in square yards computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m}. The shot blast cleaning of any longitudinal and transverse construction joints and vertical surfaces and bridge deck spall repairs will not be measured for payment.

(b) Bridge Deck Spall Repair.

Bridge deck spall repairs will be measured in square feet computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m}.

(c) Polymer Overlay.

The area of the deck acceptably overlaid will be measured in square yards computed from surface measurements taken to the nearest 0.1 of a foot {0.1 m}.

490.05 Basis of Payment.

(a) Unit Price Coverage.

1. Shot Blast Cleaning.

Payment for the measured areas at the contract unit price per square yard of "Shot Blast Cleaning" will be considered full payment for all expenses associated with the blast cleaning operation.

2. Bridge Deck Spall Repair.

The accepted quantity will be paid for at the contract unit price per square foot of “Bridge Deck Spall Repair". This price shall include all materials, equipment, tools, labor, and incidentals required to complete the work.

3. Polymer Overlay.

The accepted quantity will be paid for at the contract unit price per square yard of “Polymer Overlay". Layers will not be paid for individually. This price shall include all materials, procurement, handling, hauling and processing, coring for pull of testing, guarantee, and includes all equipment, tools, labor, and incidentals required to complete the work.

(b) Payment will be made under Item No.:

490-A Blast Cleaning – per square yard
490-B Bridge Deck Overlay – per square yard
490-D Bridge Deck Spall Repair – per square foot

DIVISION 500
STRUCTURES

SECTION 501
STRUCTURAL PORTLAND CEMENT CONCRETE

501.01 Description.

The work under this Section shall cover the furnishing of portland cement concrete to be used in constructing concrete structures. Structures shall include but are not limited to bridges of all types, box culverts, headwalls, retaining walls, and other miscellaneous structures.

501.02 Materials.

(a) General.

Handling, storage, and control of materials shall comply with appropriate portions of Section 106. All materials shall conform to the requirements set forth in Division 800, Materials. Specific reference is made to applicable portions of the following Sections:

Section 801 - Coarse Aggregate
Section 802 - Fine Aggregates
Section 806 - Mineral Admixtures
Section 807 - Water
Section 808 - Air Entraining Admixtures for Concrete
Section 809 - Chemical Admixtures for Concrete
Section 815 - Cement
Section 830 - Concrete Curing Material
Section 832 - Concrete Joint Fillers, Sealers and Waterstop Material
Section 835 - Steel Reinforcement

(b) Special Requirements.

Aggregates from different sources, which are to be used for concrete Class A and Class C as specified in Item 501.02(c)2, may be stockpiled together provided material from each source meets the requirements of Section 801 and the specific gravity of the aggregates from each source does not vary more than plus or minus 0.05.

In the event the coarse aggregate shows a tendency to segregate in the stockpile, the Engineer may order the coarse aggregate be furnished and batched in two fractions from two separate stockpiles.

The Contractor may be required to adjust the size of coarse aggregate for the concrete used around steel reinforcement of heavily reinforced members.

(c) Proportioning Materials.

1. Mixture Design.

The Contractor's concrete producer shall establish the proportion of materials for each class of concrete following the guidelines described in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete". It shall be the responsibility of the concrete producer to request approval of concrete mixture design(s) for use in Department's projects. The Contractor shall submit the proposed concrete mixture no later than 65 Calendar Days after the date of Notice to Proceed. The Department shall be allowed 28 Calendar Days to complete the review and approval of the concrete mixture.

2. Prequalification Requirements for Concrete Mixture Design.

PREQUALIFICATION REQUIREMENTS FOR CONCRETE MIXTURE DESIGN				
Concrete Class	Class A	Class B	Class C	Class D
Minimum 28-Day Compressive Strength (psi) {Mpa}	3,000 {21}	4,000 {28}	3,000 {21}	3,000 {21}
Maximum Water/Cementitious Materials Ratio	0.50	0.45	0.55	0.45
Range of Total Air Content (%)	2.5 – 6.0	2.5 – 6.0	2.5 – 6.0	2.5 – 6.0
Slump (in) {mm}	3.0 {75}	3.5 {90}	3.0 {75}	7.0 {180}
Maximum 28-Day Drying Shrinkage (%)	--	0.04	--	--
Largest Nominal Maximum Aggregate Size (in) {mm}	1.0 {25}	1.0 {25}	1.0 {25}	1.0 {25}
Notes	1, 4	1, 4	4	1, 2, 3, 4

The following notes are applicable to the table of PREQUALIFICATION REQUIREMENTS FOR CONCRETE MIXTURE DESIGN:

Note 1. Concrete mixtures used in marine environment, within 10 miles {16 kilometers} from coastline, completely or partially submerged in seawater, located within the tidal and splash zones, exposed to seawater spray, exposed to brackish water, or as shown on the plans shall have a maximum permeability of 2,000 coulombs and shall include mineral admixtures

Note 2. Seal concrete placed as an integral part of a bridge support system shall have Type II cement. Class "F" fly ash and/or ground granulated blast furnace slag shall be used as a substitute for a portion of the required Type II cement. The minimum substitution rate shall be 20 % for fly ash and 25 % for ground granulated blast furnace slag.

Note 3. Anti-washout admixtures shall be used when placing these mixtures through water.

Note 4. Coarse and fine aggregate gradations used shall meet the gradation requirements given in Section 801 and Section 802. Optimized gradations that do not meet the gradation requirements given in Section 801 and Section 802 shall be submitted to the Materials and Tests Engineer for approval prior to use.

3. Class of Concrete Required for Specific Structures.

Class A - Retaining walls, concrete safety barriers, headwalls, and inlets.
Class B – Box culverts, bridge substructures (poured in place), and bridge superstructures.
Class C - Machine laid curbs, gutters, combination curbs and gutters, slope paving, and miscellaneous concrete units..
Class D - Underwater concrete.

4. Substitution of Higher Strength Concrete and Aggregate Requirements.

Substitution of a higher strength mixture for one of a lower strength may be permitted provided all the prequalification requirements of the higher strength mixture are met and the proposed substitution is requested and approved in writing.

If requested in writing and approved by the Materials and Tests Engineer, the use of No. 357 or No. 467 aggregates may be permitted in Class D mixtures.

5. Mixture Design Prequalification Tests.

For concrete mixtures using portland cement only, the concrete producer shall submit data showing that the total alkali contribution from the cement in the concrete does not exceed 4.00 lb/yd^3 when calculated as follows:

$$lb\ of\ alkali\ per\ Yd^3 = \frac{(lb\ of\ cement\ per\ Yd^3) \times (\%\ Na_2O\ equivalent\ in\ cement)}{100}$$

Permeability tests shall be performed in accordance with the requirements given in AASHTO T 277, "Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration", using a moist-curing period of 56 days.

The 28-day shrinkage test shall be performed in accordance with the requirements given in AASHTO T 160, "Length Change of Hardened Hydraulic Cement Mortar and Concrete", using concrete prisms exposed to drying at a concrete age of 7 days. Three concrete prisms that are 3 x 3 x 11.25 inches {75 x 75 x 286 mm} in size shall be used. The initial reading for drying shrinkage calculations shall be the reading taken at the start of drying at a concrete age of 7 days ± 0.5 hours.

Compressive strength testing shall be performed in accordance with the requirements given in AASHTO T 22, "Compressive Strength of Cylindrical Concrete Specimens", using 6 x 12 inch {152 x 305 mm} cylinders.

Total air content shall be performed in accordance with the requirements given in AASHTO T 152, "Air Content of Freshly Mixed Concrete by the Pressure Method", using a Type "B" meter.

Slump test shall be performed in accordance with the requirements given in AASHTO T 119, "Slump of Hydraulic Cement Concrete".

6. Chemical Admixtures for Concrete.

Any chemical admixtures used in the concrete mixture shall be included in the mixture design proposal. Only approved chemical admixtures listed in List II-1, "Chemical Admixtures for Portland Cement Concrete", of the MSDSAR manual shall be used in Department concrete mixtures. The dosage of chemical admixtures may be adjusted in the field to obtain the desired results, provided the manufacturer's recommended dosage is not exceeded. The use of calcium chloride will not be permitted.

7. Air-Entraining Admixtures for Concrete.

Approved air entraining admixtures are listed in the MSDSAR manual, List II-1, "Chemical Admixtures for Portland Cement Concrete". The total air content shall be within the range of 2.5% to 6.0 % at the point of delivery.

Air content less than 2.5 % will be acceptable for structures that are completely embedded below the ground line or mud line.

The total air content of freshly mixed concrete shall be measured in accordance with the requirements given in AASHTO T 152 using a Type "B" pressure meter. All pressure meters used for measuring the total air content shall be calibrated prior to the beginning of concrete placement. The calibration of pressure meters shall be verified at least twice a week and anytime a questionable result is obtained.

8. Mineral Admixtures for Concrete.

Mineral admixtures may be used in any mixture design except where noted to be prohibited elsewhere. Substitution percentages are calculated by weight.

The maximum substitution of portland cement with mineral admixtures shall not exceed 50 percent. The following table shows the maximum substitution of portland cement with any one mineral admixture substitution.

MAXIMUM PERCENT MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT (substitution by weight)	
MINERAL ADMIXTURE	PERCENTAGE SUBSTITUTION
Class C or Class F Fly Ash (See Note 1)	30 %
Ground Granulated Blast Furnace Slag (See Note 2)	50 %
Microsilica	10 %

Notes to the table of MAXIMUM PERCENT MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT:

Note 1. Class “F” fly ash shall be used when fly ash is required to reduce the heat of hydration.

Note 2. The maximum substitution rate shall be twenty-five percent by weight {mass} when the ambient temperature is 45 °F or below.

9. Slump.

The Engineer may accept any concrete mixture delivered to the field with a slump less than the specified slump if the concrete mixture is workable.

A tolerance of plus 1.0 inches {25 mm} will be acceptable for the mixture delivered at the work site.

Approved Type “F”, chemical admixtures may be used to chemically increase the slump of the concrete mixture from the maximum slump specified to a maximum slump of 6.0 inches {150 mm} for Class A, Class B, and Class C concrete. The plus 1.0 in {25 mm} tolerance will not be allowed when Type “F” chemical admixtures are used.

In no case shall the water to total cementitious material ratio specified be exceeded in order to increase the slump and/or adjust the mixture.

Slump shall be measured in accordance with the requirements given in AASHTO-T-119.

10. Concrete Production.

During the progress of the work, the relative proportions between the fine and coarse aggregates, and between aggregate and water, may be varied as needed for best results, but the water to total cementitious material ratio shall not be changed except as noted below:

If it is impossible to produce concrete having the desired consistency the total amount of cementitious material may be increased to achieve the desired consistency provided that the maximum water to total cementitious material ratio is not exceeded and there is no additional cost to the Department.

If the Engineer finds it advisable to increase the minimum design strength of the concrete and orders the cementitious factor increased, the State will reimburse the Contractor for the actual amount only of the additional cementitious material used, based on actual f.o.b. destination, with the additional quantity calculated from the theoretical cementitious factor determined by the Engineer and not from count of bags or weight {mass} used.

The concrete mixture designs shall use Type I, II, or Type IL portland cement unless otherwise specified. The Contractor may, for his own convenience and without additional compensation, substitute Type III portland cement, provided prior approval is given by the Materials and Tests Engineer.

It shall be the Contractor's responsibility to carry out uniform construction practices, which will produce concrete with the specified plastic concrete properties and of not less than the minimum specified compressive strength. Concrete with compressive strength below the minimum specified compressive strength will be investigated in accordance with ALDOT-170 prior to repairing or removing the affected concrete. Should low compressive strength occur consistently, the Materials and Tests Engineer may order corrective action as deemed necessary, without additional cost to the Department.

Where the conditions require the use of low tricalcium aluminate cement, the plans or proposal will designate Type II portland cement. In such case, if requested and approved in writing, Type I or Type IL blended cement containing a maximum of eight percent tricalcium aluminate may be used. Should Type III portland cement be permitted, a maximum of eight percent tricalcium aluminate shall still apply.

(d) Sampling and Inspection.

Production of required aggregate gradation in the concrete mixture shall be the Contractor's responsibility.

Cement, aggregates, water, and chemical and mineral admixtures shall be accepted on the basis of requirements currently listed in the Department's Testing Manual.

The Department reserves the right to take samples of aggregates from stockpiles, cementitious materials from storage bins, and chemical admixtures from storage tanks at the mixing or batching plant and to make further tests as needed as the basis for continued acceptance of the materials.

The Contractor shall furnish, without extra compensation, samples of the materials and the concrete mixture for making tests and test specimens as required to comply with the Department's Testing Manual. Additional testing may be required if deemed necessary by the Engineer.

The Contractor shall furnish, without extra compensation, a protected environment for all concrete test cylinders produced incidental to any placement of concrete. This shall be accomplished by supplying a cylinder curing box with a minimum capacity of 22 test cylinders 6" X 12" {150 mm X 300 mm} in size, equipped with heating/cooling capabilities, automatic temperature control, and a maximum/minimum (high/low) temperature readout. The protective environment shall be capable of protecting all specimens within the following specification requirements and it shall be available at each site when concrete is placed and then maintained until such time that all specimens have been transported from the project to the testing facility. The Engineer, prior to beginning any concrete placement, shall approve each protective environment.

Immediately after being struck off, the concrete test specimens shall be moved to the protective environment where they shall remain for an initial curing period of not less than 24 hours or more than 48 hours. During the initial curing period, the specimens shall be stored in a moist environment at a temperature range between 60 ºF to 80 ºF {16 ºC to 27 ºC}, preventing any loss of moisture for up to 48 hours. At all times the temperature in and between concrete specimens shall be controlled by shielding the specimens from cooling/heating devices and direct rays of the sun.

A temperature record of the specimens shall be established by means of maximum/minimum (high/low) thermometers supplied by the Contractor. Only plastic molds shall be used for concrete specimens to be immersed in water.

Concrete specimens that are to be transported to the laboratory for standard curing within 48 hours shall remain in the molds in a moist environment, until they are received in the laboratory, removed from molds, and placed in standard curing.

Concrete specimens that are not transported to the laboratory for standard curing within 48 hours shall be removed from the molds within 24 ± 8 hours and standard curing used until transported to the laboratory. During the standard curing period, the specimens shall be stored at a temperature of 73 ± 3 ºF {23 ± 2 ºC} using the cylinder curing box defined above. Standard curing shall comply with AASHTO T 23 “Making and Curing Concrete Test Specimens in the Field”, Standard Curing section.

501.03 Construction Requirements.

(a) General.

All materials, labor, equipment, tools, and machinery necessary for forming, mixing, placing, finishing, and curing shall be available as required and all necessary equipment for the proper construction and completion of any section of the work shall be in satisfactory working condition before the Contractor will be permitted to start placing concrete.

All concrete batching plants supplying concrete shall be on List I-7, "Portland Cement Concrete Producers", of the MSDSAR manual. The concrete producer shall submit a valid BMT-75 and proof of NRMCA certification to the Area Materials Engineer prior to batching concrete.

All batching plants shall meet the requirements of the Specifications and ALDOT-352. Producers who request that their batching plants be placed on the list of evaluated ready-mix concrete plants will be charged a fee as specified by ALDOT-355, "General Information Concerning Materials, Sources, and Devices With Special Acceptance Requirements".

(b) Equipment.

1. General.

The Contractor shall furnish equipment capable of producing concrete meeting the requirements noted in this Section in sufficient quantities to provide for orderly construction of the project. All equipment must be in good working order and so maintained throughout the requirement for its use.

Specific requirements for certain types of equipment are designated in subsequent items of this Subarticle.

2. Mixing and Transporting Equipment.

Concrete for all major structure work (bridges, culverts, retaining walls, etc.) shall be "ready-mixed" concrete. Ready-mixed concrete is defined as portland cement concrete manufactured for delivery and delivered to the work site in accordance with AASHTO M 157 “Ready-Mixed Concrete” Modified* and the requirements written herein in other parts of these specifications. In case of discrepancy these specifications shall govern.

*Modification of AASHTO M 157. The requirements of Paragraph 8.1 shall include the following: “Should this method of measuring fly ash or other cementitious materials cumulatively with cement produce unsatisfactory results, it shall be discontinued and separate scales and hoppers provided for these ingredients.”

Concrete for minor structure work (headwalls, inlets, junction boxes, and other miscellaneous individual concrete units requiring three cubic yards {3 cubic meters} or less of concrete, along with such items as slope paving, sidewalks, curbs, gutters, and combinations thereof) may be mixed in mixers as noted above or an approved type of mobile mixing plant designed with separate bins for fine aggregate, coarse aggregate, cement, water, additives, etc. that will automatically proportion all concrete aggregates either by weight {mass} or volume and be capable of combining the ingredients into a uniform mass and discharging such without segregation. It shall have approved equipment that will determine the volume of concrete dispatched. Said alternate type mobile mixing plant shall be capable of providing concrete complying with the mixture design requirements noted in Article 501.02. Prior written approval of such alternate equipment shall be obtained before it is allowed on the project. Basis for this approval will be upon the satisfactory performance of the equipment when checked in accordance with the provisions of AASHTO M 241 "Concrete Made by Volumetric Batching and Continuous Mixing". The costs of all materials and labor furnished to perform the above mentioned test shall be absorbed by the Contractor,

If the Contractor requests to use portable concrete mixers equal or less than 15 cubic feet {0.5 cubic meter}, the Materials and Tests Engineer may approve their use and will furnish written requirements covering such mixers.

All mixing and transporting equipment shall be supplied in sufficient amounts to provide continuous delivery of the concrete as needed for an acceptable, satisfactory operation. The volume of concrete mixed or transported in a concrete truck mixer shall not be less than 15% of the gross volume of the drum.

Concrete transit mixers shall be equipped with either an in-line water meter or a sight gauge to accurately measure the amount of water discharged into the drum. In-line water meters shall be accurate to within ±1.0% of the designated quantity; sight gauges shall be accurate to within ±1.0 gallon. Water measuring devices shall be considered acceptable if the truck has been certified by NRMCA as part of their Delivery Fleet Inspection. The NRMCA Delivery Fleet Certification Card shall be affixed in a prominent location on the truck, such as the windshield or driver’s side door. Trucks shall be recertified annually, in accordance with NRMCA policy. The concrete producer shall maintain a record of their NRMCA certified trucks, available for review by the Department at any time. Additionally, the accuracy of water meters and sight gauges shall be verified in accordance with ALDOT-407, “*Verification of Water-Measurement Devices for Concrete Delivery Vehicles*”.

Each transit mixer shall be equipped with an approved automatic counter that will record the number of drum revolutions regardless of the drum speed.

3. Vibrators.

Vibrators shall be of an approved internal vibrating type and design, unless the Engineer gives special authorization for other types. Vibrators shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4500 impulses per minute. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. At least one standby vibrating unit in workable order shall be available before the start of any placement of concrete.

(c) Addition of Water at Jobsite.

Field addition of water to concrete shall be allowed only upon arrival of the truck at the jobsite, if slump tests indicate the mix is too stiff. If water is added, the drum shall be turned an additional 30 revolutions prior to discharging any more concrete. In no instance shall the maximum water-cementitious ratio of the mixture design, or the maximum slump be exceeded. Tests for slump, total

air content, temperature & compressive strength shall be run after the addition of water at the jobsite, regardless of any previous testing.

(d) Time, Light and Weather Limitations.

1. Time of Hauling and Placing Concrete.

The delivery and placement of ready-mixed concrete shall be completed within the time frames listed in the following table. These times are measured from the time at which water is added to the cement until the time at which placement of the load is completed.

TIME LIMITATIONS FOR THE DELIVERY AND PLACMENT OF CONCRETE		
Temperature of the Concrete	Mixtures without Retarding Admixtures	Mixtures with Retarding Admixtures
Less than 85 ºF {30 ºC}	1 Hour	1 Hour and 45 Minutes
85 ºF {30 ºC} or More	45 Minutes	1 Hour and 15 Minutes

If Type III portland cement is used, the time limits shall be reduced by 15 minutes. If requested, and approved in writing by the Materials and Tests Engineer, a hydration stabilizer can be used to extend the retardation of set time of concrete.

The Materials and Tests Engineer may permit mixing and the adding of the cement and additives at the work site in truck mixers, in order to meet the time limitation requirements.

When a ready-mixed truck is used for concrete delivery, the concrete shall be completely discharged from the mixing drum before the truck mixer has completed 300 revolutions and or before the above time limitations for placement have been exceeded; whichever happens first.

2. Light.

All concrete shall be placed and finished during daylight hours, unless written permission to the contrary is given. Such permission will not be given unless an adequate approved lighting system is available for all operations after sundown.

3. Weather.

a. General.

The temperature of the concrete, at the time of placing in the forms shall not be less than 50 ˚F {10 ˚C} nor more than 95 ˚F {35 ˚C}, except that for bridge deck slabs the temperature of the concrete at the time of placing shall not be more than 90 ºF {32 ºC }, unless otherwise provided or directed.

b. Cold Weather Operations.

No concrete shall be placed when the ambient air temperature is below 40 ˚F {5 ˚C} without written permission of the Engineer. If the Contractor proposes to place concrete during seasons when there is a probability of temperatures lower than 40 ˚F {5 ˚C}, the Contractor shall have available on the project such suitable approved equipment and materials as necessary to enclose the uncured concrete and keep the air temperature inside the enclosure within the following ranges and for the minimum times noted hereinafter.

If there are indications there will be temperatures below 40 ˚F {5 ˚C} during the first three days after placement of concrete, it shall be protected from cold temperatures by keeping the surface at a temperature above 50 ˚F {10 ˚C} for the first 72 hours after placement and above 32 ˚F {0 ˚C} an additional 72 hours. However, the protective covering shall be retained in place until the temperature inside the protective covering reaches that of the surrounding atmosphere.

When the Contractor is permitted to place concrete at temperatures below 40 ˚F {5 ˚C}, the aggregates and/or mixing water shall be heated as necessary to keep the temperature of the plastic concrete above 50 ˚F {10 ˚C} from the time of placement to the time of initial set; however, in no case shall the materials be heated in excess of 150 ˚F {65 ˚C}, nor shall aggregates from frozen stockpiles be incorporated into the mixture. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salts, chemicals, or other materials shall not be incorporated in the concrete to prevent freezing. Care shall be taken to heat all materials uniformly and avoid hot spots that will burn or overheat the materials.

The Contractor shall assume all risk and added cost connected with mixing, placing and protecting of concrete during cold weather. Permission given by the Engineer to place concrete during such time will in no way relieve the Contractor of responsibility for satisfactory results.

Should it be determined at any time that concrete placed under such conditions is found to be unsatisfactory, it shall be removed and replaced with satisfactory concrete by the Contractor without extra compensation.

c. Hot Weather Operations.

The following hot weather operations practices shall be followed for all concreting done between June 1 and September 15 of each year, and any other time when the temperature of the concrete may be above 95 ºF {35 ºC} or 90 ºF {32 ºC} for bridge deck slabs.

The Contractor shall submit in writing a proposed plan for controlling the concrete mixture temperature during hot weather operations. The hot weather concrete plan shall outline the Contractor's procedures to maintain the temperature of the concrete at or below the temperature requirements noted above, and the Contractor's procedures for transporting, handling, placing, finishing, and curing concrete during hot weather. The hot weather concrete plan shall be submitted at the pre-construction conference to the Area Materials Engineer for approval before any concrete placement is allowed.

During hot weather operations an approved retarder admixture shall be used in the concrete mixture, and the concrete shall be properly placed and finished with the procedures previously submitted by the Contractor. Cooling of the mixing water and/or aggregates or placement during the cooler part of the day may be required to meet the above maximum temperature requirements. In no instance shall a concrete bridge deck slab mixture be placed when the temperature of the plastic concrete is above 90 ˚F {32 ˚C}. When the temperature of the steel is greater than 120 ºF {50 ºC}, the steel forms and reinforcement steel shall be cooled prior to concrete placement. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete placing temperature.

(e) Handling and Placing Concrete.

1. General.

In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Temporary struts, stays, or braces serving to hold the forms in place until the concrete is placed shall be removed prior to being encased in the concrete. All permanent struts, stays, or braces shall be precast concrete struts or, at the Contractor's option, approved steel struts; no wooden struts shall be permitted.

During the placing of concrete, the Contractor shall continuously check the alignment of forms and immediately correct any yielding of the forms or falsework.

Concrete shall be deposited continuously for each monolithic section of the work by placing the fresh concrete in horizontal layers of approximately 12 inches {300 mm} in thickness. Each additional layer shall be placed and compacted before the preceding layer has taken its initial set, 45 minutes for mixtures without retarder and 60 minutes for mixtures with retarder.

For vertical members the maximum height of concrete placement shall not exceed 20 feet {6 m}, except for underwater concrete or when steel forms are used. When structurally sound steel forms are used, concrete placement may be made up to 30 feet {9 m} in height provided that an approved mortar tight downspout of sufficient length to reach within 5 feet {1.5 m} of the bottom of the placed concrete and a vibrator of sufficient length to provide good consolidation throughout the concrete placement are used. Any vertical member exceeding 20 feet {6 m} in height shall be broken into two or more approximately equal concrete placements unless the preceding requirements are met.

When succeeding concrete placements are necessary, the next concrete placement will not be permitted until the concrete in the underlying placed concrete has aged at least 12 hours or attained a minimum compressive strength of 2400 psi {17 MPa} from cylinders prepared in conformity with AASHTO T 23. When a set retarding admixture is used in the preceding concrete placement, the next concrete placement shall not be permitted until a 2400 psi {17 MPa} cylinder strength is attained.

The forms shall not be jarred nor shall any strain be placed on reinforcing bars partially encased in concrete that will cause damage to bond. All accumulations of mortar splashed on the reinforcing steel and surfaces of forms shall be removed before the next concrete placement.

When it is necessary to pump water from the excavation during placing of concrete to deposit the concrete in the dry, the sump for the intake hose shall be located outside the forms.

The use of aluminum pipes, chutes, or other devices made of aluminum that come into direct contact with the concrete shall not be utilized in the handling and placing operations.

a. Use of Chutes, Pipes or Belts.

Concrete shall not be dropped a distance of more than 5 feet {1.5 m} unless confined in an approved mortar tight downspout of not less than 4 inches {100 mm} in diameter. Downspouts shall be equipped with suitable hoppers at their inlet end and shall be provided in sectional lengths that will permit adjustment of the level of the outlet during placement.

The number of downspouts furnished shall be sufficient to ensure the concrete placement in horizontal layers. Depositing large quantities of concrete at one point in the form and running, flowing, or working the concrete along the forms will not be permitted.

In wall sections where a 4 inch {100 mm} downspout cannot be utilized without displacing the reinforcing steel, the concrete may be dropped in excess of the 5 feet {1.5 m} previously noted, provided such does not displace the reinforcing steel nor produce segregation of the concrete.

(1) Chutes, pipes, or power belts may be used to convey concrete from the concrete mixer or transporting vehicle to the forms, and they shall convey it to its final position without segregation and without displacing the reinforcing steel. If the use of this equipment results in honeycombed or otherwise substandard concrete, the Engineer will require it to be changed or its use discontinued.

(2) Chutes, pipes, and power belts shall be flushed with water after each run and this water shall be discharged free of the freshly placed concrete. All hardened concrete shall be promptly removed.

b. Pumping.

Direct placement of concrete by an approved pumping device will be permitted. The equipment shall be so arranged that no vibration result that might damage freshly placed concrete. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After each placement the equipment shall be cleaned to prevent improper results on subsequent operations.

c. Compacting and Vibrating.

Concrete, except underwater concrete, shall be thoroughly compacted by mechanical vibration applied internally, during, and immediately after depositing.

The application of a vibrator or vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms. Vibration shall be supplemented by as much spading as is necessary to ensure smooth surfaces and dense concrete.

The vibrators shall be methodically inserted and withdrawn from the concrete. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but vibrators shall be withdrawn before segregation and localized areas of grout result.

Vibration shall not be applied directly or through reinforcement to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. Vibrators shall not be used to make concrete flow in the forms over distances so great as to cause segregation.

2. Culverts.

See Section 524 for specific details not covered in this Section.

3. Retaining Walls.

See Section 529 for specific details not covered in this Section.

4. Bridges.

See Section 510 for specific details not covered in this Section.

5. Depositing Concrete Under Water.

a. General.

Concrete shall not be deposited in water unless provided for on the plans, or authorized as provided in Subarticle 503.03(g). Concrete placed under water shall be placed as hereinafter provided.

b. Control.

Seal concrete shall be placed continuously from start to finish ensuring the concrete placement being monolithic. The surface of the concrete shall be kept as nearly horizontal as practicable at all

times. To ensure bonding, each succeeding layer of seal or foundation concrete shall be placed before the preceding layer has initially hardened. All laitance or other foreign matter shall be removed from the top surface of the concrete, and bonding of construction joints performed in accordance with the requirements given elsewhere in this Section.

c. Placing Methods.

Concrete specified to be deposited in water shall be seal concrete as provided in Article 501.02. To prevent segregation, it shall be carefully placed in a compact mass in its final position by means of a tremie, a bottom dump bucket, pumping, or other approved method. Concrete shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit as nearly as practical.

(1) Use of Tremie.

A tremie shall consist of a rigid, watertight tube of sufficient strength to withstand the stress to which it is subjected and be at least 8 inches {200 mm} in diameter. The tremie shall be supported so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The tremie shall be plugged at the start of work with an approved device capable of separating the concrete from the water until the tube is filled with concrete. The tremie tube shall be kept partially filled with concrete at all times during the concrete placement. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the tremie, always keeping the discharge end in the deposited concrete. The flow shall be as nearly continuous as possible and in no case shall it be intentionally interrupted until the entire seal concrete foundation work is completed.

(2) Use of Bottom Dump Bucket.

The bottom dump bucket shall have a capacity of not less than 0.5 cubic yards {0.5 m^3} and be mechanically equipped to prevent dumping until it rests on the foundation or previously placed concrete. The bucket shall be completely filled and lowered very carefully until it rests upon the foundation or concrete already placed so as not to get a wash over the bucket top. It shall then be raised very slowly during the discharge travel, the intent being to maintain as nearly as possible, still water at the point of discharge and to avoid agitating the mixture; also to allow the concrete to be deposited by the time the bucket emerges from the concrete already on the foundation.

(3) Pumping.

In addition to the requirements given elsewhere in this Section, the following shall also apply for placing concrete under water by pumping. Concrete may be pumped into a tremie, or directly to the point of placement. If the concrete is pumped directly to the point of placement, a rigid pipe shall be provided that must extend a minimum of 5 feet {1.5 m} above the water level when resting on the bottom of the excavation. A flexible hose suitable for pumping concrete may be used from the top of the rigid pipe to the concrete pump. The method of placing and handling the concrete shall be as described elsewhere in this Section.

(f) Construction Joints.

1. General.

Construction joints shall be placed only at the locations shown on the plans or as directed. In case of an emergency, if a construction joint is permitted, it shall be placed as approved by the Engineer.

2. Horizontal Joints.

Generally, horizontal joints shall be made by placing the concrete slightly above the grade of the construction joint, and after the surface has reached its final set, the surface shall be prepared as outlined in Item 4 below. Insert formwork shall be used to obtain neat, horizontal lines.

3. Vertical Joints.

Vertical joints shall be formed with substantial bulkheads or headers as required. Feather-edged joints will not be permitted.

4. Bonding.

Before placing concrete against any construction joint, the surface of the hardened concrete shall be scarified in such a manner that all foreign matter, laitance, and loose material is removed to expose sound concrete. The prepared concrete at the construction joint shall be kept wet for a minimum of one hour prior to placing concrete against it. An approved epoxy, listed in the MSDSAR manual, List II-7, "Epoxy Resin Systems for Use with Portland Cement Concrete", shall be placed for

bonding freshly mixed concrete to hardened concrete. Keyways and dowels shall be placed as shown on the plans or directed.

5. Water Stops.

Water stops shall be furnished and placed as required by the plans. They shall form continuous watertight joints.

(g) Expansion Joints.

All joints shall be constructed according to details shown on the plans, providing the design width designated for the expansion joint. The insertion and removal of joint forming material shall be accomplished without chipping or breaking the corners of the concrete. Expansion material, when required, shall be placed as shown on the plans.

(h) Forms.

1. General.

Reference is made to Article 105.02 concerning working drawings and other details that require submission.

Forms shall be substantial and unyielding and so designed and constructed that the finished concrete will conform to the plan dimensions and contours within tolerances listed in other portions of these Specifications.

Basic bridge plan design is for removable forms and plan concrete quantities computed accordingly. Hence, removable forms are to be used unless stay-in-place forms are allowed by contract plan notes and details. When shown by contract plan details, the Contractor will be allowed the option of using permanent steel forms under deck slabs between girders, beams or stringers provided the cost of extra concrete and materials required by this type of form is at the Contractor's expense.

2. Design.

a. Removable Forms.

All removable forms shall be designed so that they may be removed without damage to the concrete. Forms shall be so constructed that portions where finishing is required can be removed for that purpose without loosening supports or disturbing portions of forms that must still remain in place.

b. Permanent Steel Bridge Deck Forms.

The forms and supports shall be zinc coated (Galvanized) steel conforming to ASTM A 653 with coating Class of G165 according to ASTM A 525 and shall otherwise meet all requirements relevant to permanent steel forms and the placing of concrete as specified herein and as noted on the plans. Miscellaneous fastener hardware (bolts, nuts, metal screws, and washers) shall be common stock hardware items galvanized to provide a zinc coating equal to or better than that required by ASTM B 633.

The following criteria shall govern the design of permanent steel bridge deck forms:

(1) The steel forms shall be designed on the basis of dead load of form, reinforcement, and plastic concrete plus 50 pounds per square foot {2.4 kN/m^2} for construction loads. The unit working stress in the steel shall not be more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 pounds per square inch {250 MPa}. The uncoated thickness of the forms shall not be thinner than 0.0359 inch {0.9 mm}.

(2) Deflection under the weight {mass} of the forms, the plastic concrete, and reinforcement shall not exceed 1/180 of the form span or 0.5 inches {13 mm}, whichever is less, but in no case shall this loading be less than 120 pounds per square foot {5.7 kN/m^2} total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

(3) The design span of the form sheets shall be the clear span of the form plus 2 inches {50 mm} measured parallel to the form flutes.

(4) Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.

(5) The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained. A minimum concrete cover of 1 inch {25 mm} shall be maintained for the bottom slab steel.

(6) Forms shall not be welded to any part of the structural steel main members (the definition of "main members" is given in Section 836. The installation of forms may be done by welding attachment straps together if backing plates are installed under the straps. The backing plates shall be thick enough to prevent burn-through. The width of the backing plates shall be at least one inch wider than the width of the welded attachment straps so that the backing plates extend out at least one half inch beyond each edge of the welded straps.

3. Construction.

a. Removable Forms.

(1) Forms shall be mortar tight and placed and maintained true to designated lines and grades until the concrete has been placed and hardened. Forms found unsatisfactory in any respect shall not be used and, if rejected, shall be removed from the immediate work site.

(2) All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints and all corners in the finished work shall be true, sharp, and clean cut and of good workmanship. Forms shall be filleted and chamfered at all sharp corners except where angles exceed 90°, such as at the face of bridge curbs and deck overhangs. Unless otherwise shown on the plans, the equal sides on triangular molding or chamfer shall be 0.75 inches {19 mm}, except that for small members the width shall be 0.5 inches {13 mm}.

(3) For narrow walls, columns, et cetera, the Engineer may require daylight and inspection holes at vertical intervals as directed.

(4) Bolts or ties shall be used to prevent forms from spreading. All such bolts or ties shall be arranged so that at least 1 inch {25 mm} of that part adjacent to the concrete surface can be removed or broken off.

(5) Anchor devices may be cast in the concrete for later use in supporting forms only if they are detailed on approved formwork or falsework plans.

(6) The inside of all forms shall be coated with a non-staining oil or other approved material to prevent the concrete adhering to them. Extreme care shall be exercised to ensure that form oil does not come in contact with structural or reinforcing steel.

(7) The forms shall be inspected before placing the concrete and the interior dimensions carefully checked to ensure that the concrete will be of the form and dimensions shown on the plans. The inside faces of the form shall be thoroughly examined and any projections, ridges, depressions, offsets, spaces or other unevenness corrected so that the surface of the concrete will be smooth, even and true, and mortar tight. All forms shall be wetted immediately prior to placing the concrete, but no excess water shall remain in the forms.

(8) To permit proper surface finishing, forms shall be removed as soon after the concrete has set as is practicable and safe. In the determination of the time for the removal of forms, except those listed elsewhere in this Section, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the material used in the mixture. Methods of form removal likely to cause over-stressing of the concrete shall not be used. Forms shall not be removed without the approval of the Engineer.

b. Permanent Steel Bridge Deck Forms.

(1) All forms shall be installed in a manner acceptable to the Engineer.

(2) On steel members, form sheets will not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch {25 mm} at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. The installation of attachment straps, shelf angles, and forms shall

be carefully monitored to make sure that no welding (weld, arc strike, etc.) is done to the structural steel.

On concrete girders, form supports to be cast into the girders shall be shown on the shop drawings. All attachments to form supports shall be made by permissible welds, bolts, clips, or other approved means. Attachment by welding to form supports may be performed by non-ALDOT qualified welders with welding electrodes recommended by the form manufacturer.

All form welds shall be cleaned of slag and wire brushed just prior to placing of the deck concrete.

(3) Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed, and painted with two coats zinc oxide-zinc dust primer, Federal Specification TT-P-641, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

(4) Transverse construction joints shall be located at the bottom of a flute and 0.375 inch {10 mm} weep holes shall be field drilled at not more than 12 inches {300 mm} apart along the line of the joint. If a bridge is on a skew, or in a curve, a weep hole shall be drilled in the bottom of each flute the joint crosses.

(i) Falsework.

1. Design and Construction.

a. General.

For the purpose of this specification, falsework shall be divided into two classes as follows:

Class 1 - Common or simple falsework such as temporary bracing to provide stability for bridge girders, permanent steel bridge deck forms, deck overhang supports, screed rail support systems, or substructure supports attached to permanent parts of the structure (i.e. drilled shafts, columns, caps, etc.).

Class 2 - Unique or complex falsework such as that required for box girder construction, RCDG construction, structural cofferdams, or any falsework used in connection with steel erection.

The Contractor shall be responsible for designing and constructing safe and adequate falsework which provides the necessary strength and rigidity, supports all loads imposed, and produces a finished structure with lines and grades shown on the plans. Falsework shall be designed and constructed to withstand all imposed loads during erection, construction, usage, and removal.

The Contractor shall submit to the Construction Engineer working drawings and design calculations for falsework in accordance with Article 105.02.

For both classes of falsework drawings, the Construction Engineer will verify that the licensed Professional Engineer signature and stamp requirements of Subarticle 105.02(d) are met. Class 1 drawings will be stamped for distribution and then distributed. Class 2 drawings will be forwarded to the Bridge Engineer for review to determine if the results of the licensed Professional Engineer's calculations are in compliance with design criteria. If the design criteria are met, the submittal will be returned to the Construction Engineer to be stamped for distribution and then distributed.

All falsework will be inspected by the Project Manager using the distributed drawings. For all Class 2 falsework, the licensed Professional Engineer who signed the falsework submittal shall verify that the falsework as constructed meets all design criteria prior to any load being placed thereon. A signed statement from the licensed Professional Engineer covering the verification shall be furnished to the Project Manager by the Contractor.

When falsework of either class is to be used over highway, pedestrian, or railroad traffic, additional details will be required to provide for special protection to prevent debris from falling on the traffic below. These additional details will be required for both removal and construction work.

All falsework drawings shall include a description and size of all members, connections, and miscellaneous hardware. When pre-manufactured assemblies are used, all parts shall be easily identified as those shown on the drawings.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Screw jacks and/or hardwood wedges shall be used to take up any settlement in the formwork either before or during the placing of concrete.

Any part of the permanent structure to which falsework will be attached shall attain a minimum compressive strength of 2400 psi {17 MPa} from cylinders prepared in conformity with AASHTO T 23 prior to the attachment.

Falsework that cannot be founded on a satisfactory footing shall be supported on piling, which shall be spaced, driven, and removed in an approved manner.

All spans shall be given a temporary camber to allow for deflection, shrinkage, and settlement. Bridges shall have a permanent camber only where so shown on the plans or directed.

b. Design Criteria.

Falsework shall be designed to withstand all imposed loads during erection, construction, usage, and removal. Designs shall be based on minimum loads, maximum stresses and deflections, and conditions in the following paragraphs. Allowable stresses are based on use of undamaged, high quality materials. The contractor shall reduce stresses if lesser quality materials are used.

Design Loads for falsework shall consist of the sum of dead and live vertical loads and assumed horizontal loads. Minimum total design load for any falsework shall not be less than 100 pounds per square foot {4.8 kN/m^2} for the combined live and dead load regardless of slab thickness.

Dead Loads shall include weight {mass} of concrete, reinforcing steel, forms, and falsework. Weight {mass} of concrete, reinforcing steel, and forms shall not be assumed to be less than 160 pounds per cubic foot {25 kN/m^3}.

Live Loads shall consist of the actual weight {mass} of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than 20 pounds per square foot {0.960 kN/m^2} applied over the area supported plus 75 pounds per linear foot {1.1 kN/m} applied at the outside edge of deck overhangs.

Horizontal Loads applied shall be the sum of the actual horizontal loads due to equipment, construction sequence, or other causes and an allowance for wind, but in no case shall the design horizontal load to be resisted in any direction be less than two percent of the total dead load. Falsework shall be designed of sufficient rigidity to resist the design horizontal load prior to placement of concrete.

Falsework Foundations shall be designed to carry the loads imposed on them without exceeding allowable soil bearing values and anticipated settlements.

Maximum allowable stresses, loadings, and deflections used in design of falsework shall be as follows:

TIMBER	
Compression perpendicular to the grain (Dense Select Structural Grade Southern Pine)	450 psi {3 MPa}
Compression parallel to the grain but not to exceed 1600 psi {11 MPa}	480,000/$(L/D)^2$ psi {3300/$(L/D)^2$ MPa}
Flexural stress reduced to 1500 psi {10 MPa} for members with a nominal depth of 8 inches {200 mm} or less.	1800 psi {12 MPa}
Horizontal shear (Dense Select Structural Grade Southern Pine)	90 psi {0.620 MPa}
Deflection due to weight {mass} of concrete.	1/240 of clear span irrespective of the fact that the deflection may be compensated for by camber strips.
Timber piles, maximum loading (12 inch {300 mm} Butt Diameter)	24 tons {213 kN}

STEEL	
Deflection due to weight {mass} of concrete irrespective of the fact that the deflection may be compensated for by camber strips.	1/240 of clear span
Stresses shall not exceed those specified in the Manual of Steel Construction as published by the AISC. When the grade of the steel cannot be positively identified, design stresses shall conform to either those specified in said AISC Manual for ASTM A 36 steel or the following:	
Tension, axial and flexural.	22,000 psi {152 MPa}
Compression, flexural (But not to exceed 22,000 psi {152 MPa})	12,000,000 / (LD/bt) psi {83 000/ (LD/bt) MPa}

Compression, axial.(Except L/r shall not exceed 120.)	16,000 - 0.38(L/r)^2 psi {110 - 0.38(L/r)^2 MPa}
Shear on gross section of the web of rolled shapes.	14,500 psi {100 MPa}
Web crippling for rolled shapes	27,000 psi {186 MPa}

In the foregoing formulas, L is the unsupported member length, D is the least dimension of rectangular columns, or the width of a square of equivalent cross sectional area for round columns, or the depth of beam, b is the width of member, t is the thickness of the compression flange and r is the radius of gyration of the member. E, modulus of elasticity, used for timber shall be 1.6 X 10^6 psi {11 GPa} and for steel shall be 30 X 10^6 psi {200 GPa}.

Any additional design criteria, which may be needed, shall be developed by the Contractor's licensed Professional Engineer designer and included with the calculations of the falsework submittal.

Falsework over or adjacent to roadways or railroads which are open to traffic during construction shall be designed and constructed such that it is stable if subjected to vehicular impact or features shall be provided to protect falsework supports from vehicular impact. Protection shall be designed such that it does not present a hazard to vehicular traffic.

Design criteria for permanent steel bridge deck forms shall be as shown elsewhere in this Section.

2. Removal of Falsework.

No falsework supporting concrete shall be removed or wedges loosened without the consent of the Engineer.

If adequate test cylinders have been made, falsework may be removed when the cylinders indicate that the concrete has developed a minimum compressive strength of 2400 psi {17 MPa}, otherwise falsework shall be removed according to the following time limitations.

Falsework may be removed after expiration of 14 days exclusive of days when for four hours or more the temperature is below 40 °F {5 °C}. Falsework under slabs of less than 6 foot {2 m} span may be removed after seven days with the same temperature limitations.

Falsework shall be gradually and uniformly released in such a manner as to avoid injurious stresses in any part of the structure. Wedges shall be removed first under slabs and transverse beams, starting at the center of the span and working both ways; then wedges under longitudinal girders and beams shall be removed also starting at the center of the span and working both ways simultaneously.

All falsework piles, at the time of removal or cleanup, shall be pulled out or cut off at an elevation not more than 6 inches {150 mm} above the bed of the stream. Piles not in water shall be removed or cut off flush with or below the ground surface of stream bed. Piles within roadbed limits shall be cut off at least 3 feet {1 m} below subgrade elevation. Other piles within roadway limits shall be cut off at least 12 inches {300 mm} below the finished surface of the front slope, ditch, or backslope.

(j) Curing Concrete.

1. Exposed Surfaces.

Whenever the Engineer determines that weather conditions are such that evaporation from the surface may cause shrinkage cracking, a fog or mist spray may be required at intervals as needed during and after finishing until curing material can be applied so that the surface will be at all times damp but not excessively wet.

The Contractor shall give careful attention to the proper curing of the concrete. All surfaces not covered by forms shall be protected with an approved membrane curing compound, from List II-30 of the MSDSAR manual, dampened burlap, Polyethylene Film* (White Opaque), White Burlap - Polyethylene Sheet*, cotton mats, or wetted sand, as soon after placing the concrete as possible without marring the surface, except for bridge deck slabs which shall be treated as noted in Item 2 below. Immediately upon removal of forms, other surfaces shall be treated by one of the approved curing methods.

Unless membrane curing compound is used, all curing materials shall be kept wet and shall remain in place for seven days, except that small portions may be temporarily removed during actual finishing operations.

*Note: When polyethylene film or white burlap-polyethylene sheeting is used, it shall be installed and maintained in such a manner that a complete, moisture-tight enclosure over the surface

to be cured will be provided. These materials shall meet the requirements noted in Section 830.

2. Bridge Deck Slabs.

a. General.

Prior to placing a bridge deck slab, the evaporation rate shall be determined by use of the graph in Figure 1, "Evaporation Rate of Surface Moisture", and recorded on form BMT-171, *"Evaporation Rate Record"*. The Contractor shall furnish the equipment necessary to measure the air temperature (ambient), wind velocity, and humidity. The equipment or a manufacturer's certificate of calibration showing the equipment's model number and serial number shall be submitted to the Area Materials Engineer no less than 14 days prior to their use. The equipment shall consist of the following instruments with the following specifications.

(1) Anemometer:
Range – 0-25mph {0-40 km/hr}.
Accuracy – plus or minus 1.5%.
Units – U.S. Customary and Metric.

(2) Hygrometer:
Range – 10-95% relative humidity.
Accuracy – plus or minus 1.5%.
Units - U.S. Customary and Metric.
Certified and traceable to N.I.S.T.

(3) Thermometer:
Range – 0-140 °F {0-60 °C}.
Accuracy – plus or minus 2 °F {plus or minus 1 °C}
Units - U.S. Customary and Metric.

Combination instruments such as anemometer and thermometer or hygrometer and thermometer will be accepted provided they meet the above requirements.

If the placement is expected to last more than two hours, the evaporation rate shall be checked and recorded on form BMT-171 at two-hour intervals or less. To prevent plastic shrinkage cracking, the expected evaporation rate shall not exceed 0.2 pounds per square foot per hour {1.0 kg/m^2/hour}. When the evaporation rate exceeds this amount, the Contractor shall be required to effectively reduce the rate to within the allowable limits by taking one or more of the following actions:

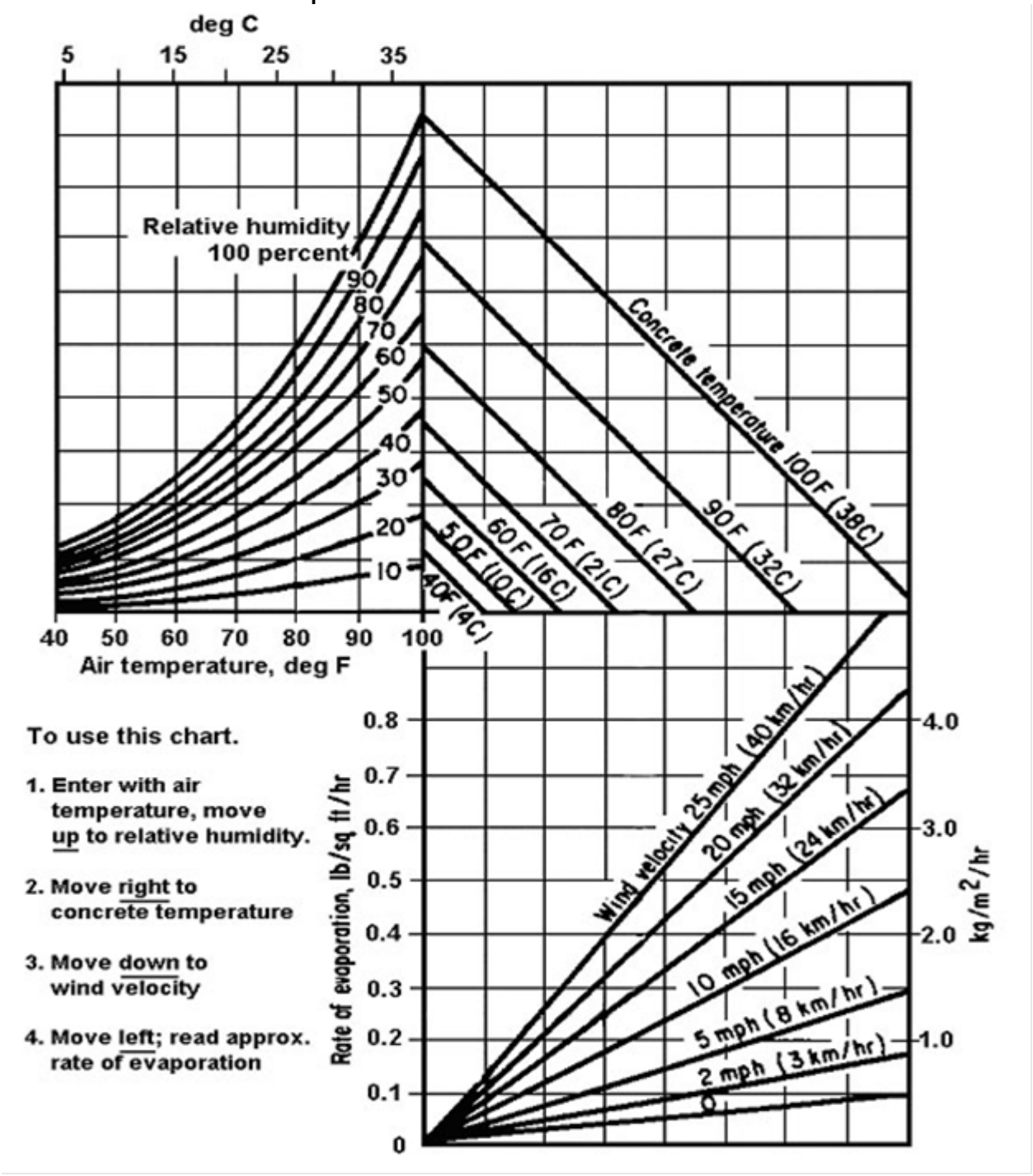
(1) Construct windbreaks or enclosures to effectively reduce the wind velocity throughout the area of placement.

(2) Use fog sprayers or sprinklers upwind of the placement operation to effectively increase the relative humidity.

(3) Reduce the temperature of the concrete.

The Department will evaluate plastic shrinkage cracks that occur. Remedial measures shall be performed as directed by the Engineer. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

FIGURE 1. Evaporation Rate of Surface Moisture



b. Evaporation Control After Screeding.

Continuous fogging or an evaporation barrier (monomolecular) material shall be used for all bridge deck curing beginning immediately after the screeding operations have been completed for sections of the deck not to exceed five feet from the starting location.

If fogging is to be used, a continuous fog or mist spray shall be maintained until the moist curing procedures described elsewhere in this Section begin. Intermittent fogging is not acceptable if there is drying of the concrete surface. If water begins to pond on the deck, the Contractor shall adjust the rate of fogging to minimize the ponding of water.

If an evaporation barrier material is to be used, it shall be applied immediately behind the screeding operation and in accordance with the manufacturer's recommendations. The entire top

portion of the concrete slab shall be covered with the barrier material applied under pressure at a rate of one gallon {liter} to not more than 200 square feet {5 m^2} of fresh concrete. Application shall be done with an industrial type sprayer in such a manner as to cover the surface being treated with a uniform film.

c. Moist Curing After Finishing.

Immediately after the finishing operation, concrete bridge decks shall be moist cured for seven days by maintaining a moist condition for the entire curing period. This may be accomplished by one of the following methods:

(1) Fog spraying or sprinkling with nozzles or sprinklers. When using this method, the Contractor shall maintain a complete and continuous moist condition of the concrete surface. Intermittent sprinkling is not acceptable. Care shall be taken that erosion of the surface does not occur.

(2) Saturated burlap, saturated plastic coated burlap, or cotton mats. These curing materials shall be clean and free from any injurious substances that can cause deleterious effects to the concrete or cause discoloration. The burlap or cotton shall be completely saturated before being placed on the concrete and shall be maintained in that condition for the entire curing period. Should tears or holes appear in the mat sheets, they shall be repaired immediately. All edges of burlaps and mats shall extend at least 18 inches {450 mm} beyond the concrete surface. Where two individual sheets join, their edges shall overlap at least 12 inches {300 mm}. All edges and overlaps shall be secured to ensure that the concrete surface is completely covered during the entire curing period. These curing materials shall be kept in contact with the concrete surface at all times. Alternate cycles of wetting and drying shall be avoided because this may result in pattern cracking.

Prior to the start of the curing operation, the contractor shall have an approved curing system that ensures continuous moist curing of the concrete for 24 hours per day.

If water or the chosen curing material stains or discolors concrete surfaces, which are permanently exposed, the contractor shall be responsible for cleaning the surfaces. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, non-supporting vertical forms shall be broken loose from the concrete and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces.

3. Protection of Concrete during Curing.

Green concrete shall be protected against jarring or other movement that might cause damage. No traffic or other superimposed load will be permitted over bridges or culverts until the following criteria have been met:

(1) Bridges - The concrete shall have reached a minimum 4000 psi {28 MPa} compressive strength as determined from test cylinders.

(2) Culverts - The culvert concrete shall have reached a minimum of 4000 psi {28 MPa} compressive strength as determined from test cylinders or 28 days have passed since the last concrete was placed exclusive of days when for 4 hours or more the temperature is below 40 °F {5 °C}.

(k) Finishing Concrete.

1. General.

The details set forth hereinafter in this Subarticle cover the requirements for the several classes of surface finishes which shall be applied to the various parts of concrete structures.

These various classes of surface finishing will be used in accordance with the following:

Class 1 - required on all concrete surfaces except wearing surfaces and surfaces placed in direct contact with natural ground or embankment.

Class 2 - required on all exposed concrete surfaces within the requirements noted elsewhere in this Section unless another class is specified.

Class 3 - may be used on designated bridge structures when specified by plan details.

Wearing surface finish for bridge deck travelway shall be as specified in Subitem 510.03(c)6.c. and for sidewalks as specified in Item 510.03(c)7.

Exposed surfaces or sidewalks, driveways, curbs, and gutters shall have a textured finish obtained by the use of a burlap or cotton drag, brush, or broom so that a uniform gritty texture is obtained. Exposed surfaces of concrete flumes and slope paving shall have a float finish.

2. Class 1 Finish (Ordinary Surface Finish).

This class finish will require the concrete surface to be free from objectionable projections, swells, fins, ridges, depressions, waves, holes, and other defects. This will require that immediately after the forms are removed, metal ties shall be removed for a minimum depth of 1 inch {25 mm} from the face of the concrete. All cavities or depressions resulting from this removal, or from other causes, shall be carefully filled and pointed with a mortar of sand and cement, and the surface left smooth and even. The proportion of cement to sand, measured by volume, shall be one to two unless otherwise specified. The surface film of all pointed areas shall be carefully removed before setting occurs. Any fins, ridges, or projections shall be struck off smooth with the surface of the concrete. Particular care shall be taken throughout the progress of this operation to use one of the curing methods covered elsewhere in this Section.

If a Coated Surface Finish is to be applied in a later finishing operation, the coating material may be used in lieu of mortar to fill small air holes in the concrete surface; however, this must be given time to take a set prior to applying the Coated Surface Finish.

3. Class 2 Surface Finish.

a. General.

This class surface finish requires that, in addition to a Class 1 finish, the exposed surfaces of bridges, culverts, headwalls, inlets, etc. as defined in the Subitem d. below, receive an additional surface finish in accordance with the following:

If only one brand and type of cement from the same mill is used in a structure or unit (substructure or superstructure), the Contractor may elect to either apply a Rubbed Surface Finish or apply an approved coated Surface Finish.

If more than one brand of cement is used in a structure, the Contractor shall apply a Coated Surface Finish.

The same type of surface finish shall be used throughout the entire structure unless otherwise authorized in writing by the Engineer.

b. Rubbed Surface Finish.

As soon as the Class 1 surface finish has been completed and the pointing has set sufficiently to permit it, the entire surface except chamfers shall be wetted with a brush and rubbed with a No. 16 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth dense surface without pits or irregularities. The material, which in the above process has been ground to a paste, shall then be carefully spread or brushed uniformly over the entire surface and allowed to take a reset. Curing shall continue on this surface as noted to be required elsewhere in this Section.

The final finish shall be obtained by a complete rubbing with a No. 30 carborundum stone or an abrasive of equal quality. This rubbing shall continue until the entire surface is of a smooth texture and uniform in color.

c. Coated Surface Finish.

Only Departmental approved coated finishing materials may be used. The coating material shall be one of the coating materials shown on List III-3, "Surface Coatings for Portland Cement Concrete". This list is given in the Department’s Manual, “Materials, Sources, and Devices with Special Acceptance Requirements”.

The application of the coating shall be in an approved manner (normally in accordance with the manufacturer’s recommendations) by competent and experienced personnel. The overall coated finish shall be uniform in coverage, texture, and color after the coating material has taken set and cured. Failure to obtain uniformity of coverage, texture, and color shall be cause for the Engineer to require such remedial action as deemed necessary to obtain the desired results.

The following actions shall be taken before the application of any coated finish:

A Class 1 surface finish shall be applied and all pointing completely set.

Surface shall be cleaned and free from foreign matter.

If membrane curing compound was used to cure the concrete, the curing compound shall have weathered for a minimum time period of six weeks. Special care shall be taken to ensure that areas not to be treated are protected to prevent treatment from overlapping onto these designated areas.

d. Exposed Surfaces.

Exposed surfaces for this class finish is defined as all surfaces, including bottom chamfers and fillets except (1) the wearing surface of roadway slabs and sidewalks, (2) those surfaces having immediate contact with embankment or excavation, (3) those surfaces below low water level and/or

below newly established ground line after backfilling excavation or excavated channels, (4) underside and interior faces of girders, beams, and slabs, and underside of sidewalks where the edge beam extends 3 inches {75 mm} or more below the bottom of the sidewalks, (5) top and bottom surfaces of all type caps, and (6) those parts of minor structures, box culverts, and bridge culverts that are not readily visible from a travelway.

4. Class 3 Surface Finish.

This class surface finish requires that, in addition to the Class 1 surface finish, only the designated exposed surfaces of a bridge structure noted below be given an additional finish of either a rubbed or coated finish in accordance with the requirements given elsewhere in this Section.

Exposed surfaces shall be defined as the inside, top, and outside surfaces of barrier rail to bottom of slab overhang, and all portions of the bridge abutments outside the edge of the exterior girders that are not in immediate contact with embankment or excavation. All other structure surfaces, exposed and unexposed, shall receive a Class 1 finish immediately after the forms are removed.

(l) Concrete for Precast Non-Prestressed and Prestressed Members.

Concrete for precasting shall meet the requirements given in this Section unless amended by concrete requirements given in other Sections.

Additional requirements are given in Section 512 and ALDOT-367 for the concrete required for precast non-prestressed concrete bridge members. Additional requirements are given in Section 513 and ALDOT-367 for the concrete required for precast prestressed concrete bridge members.

501.04 Inspection.

(a) General.

The Contractor shall give the Engineer sufficient advance notice before starting to place concrete in any section of a structure to permit the inspection of forms, placing of steel reinforcements, and of preparation for placing. Any defective falsework or forming shall be corrected, or removed and replaced as necessary to the satisfaction of the Engineer, all at the expense of the Contractor.

Authorization of the Engineer shall be secured before concrete is placed in any portion of a structure. Any concrete placed in violation of this provision, or in the absence of the Inspector, shall be removed and replaced at no additional cost to the State.

(b) Removable Forms.

After the forms have been removed, any defective work discovered shall be removed and replaced in a satisfactory manner. If the surface of the concrete is bulged, sagged, uneven, or honeycombed to such an extent that it cannot be satisfactorily repaired, the entire section shall be removed and replaced, at no additional cost to the State.

(c) Stay In Place Steel Forms.

After the deck concrete has been in place for a minimum period of two days, the concrete, if deemed necessary by the Engineer, shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. The number and locations of the forms to be tested shall be as selected by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the concrete has attained a minimum compressive strength of 2400 psi {17 MPa}. Care shall be exercised to distinguish the sound of broken bond from the sound of defective concrete.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention. As soon as the forms are removed, the concrete surfaces will be examined for cavities, honeycombing, and other defects. If irregularities are found, and in the opinion of the Engineer these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct. If the concrete where the forms are removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the Contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slabs. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures. No additional compensation will be allowed the Contractor for compliance with the above inspection procedures.

501.05 Acceptance of Concrete.

(a) General.

Certified Concrete Technicians, as required by the Department, shall perform all concrete inspections and testing. Procedures for technician certifications and laboratory qualifications are described in ALDOT-405, "Certification and Qualification Program for Concrete Technicians and Concrete Laboratories".

Fresh concrete will be accepted on the basis of slump, total air content, and temperature meeting the requirements specified for the Class of concrete.

Hardened concrete shall be accepted on the basis of compressive strength meeting the requirements specified in Item 501.02(c)2 for that Class of concrete.

Compressive strength from concrete cylinders will be accepted when the average of two consecutive cylinder test results, obtained at the same age, equals or exceeds the specified 28-day compressive strength, and neither cylinder test result is below 95% of the specified 28-day compressive strength.

(b) Substandard Concrete.

1. General.

The Department will investigate any concrete not meeting the acceptance requirements outlined in Subarticle 501.05(a). Concrete investigations will be used to determine the suitability of potentially substandard concrete. This investigation may include any or all of the procedures outlined in ALDOT-457.

The combined results of the Department's investigations will be used to assess the acceptability or rejection of potentially substandard concrete.

If the investigation results show that the concrete fails to meet the contract requirements, the Contractor shall be responsible for the cost of the investigation to include, but not limited, to per-diem, travel expenses, and sampling and testing.

In instances where the Department determines it is impractical or unfeasible to core the in-place concrete represented by substandard cylinder breaks, the concrete will be accepted with a price adjustment equivalent to the cylinders' percentage of the specified 28-day compressive strength. If the average 28-day compressive strength of the cylinders is less than 70% of the specified 28-day compressive strength, the concrete will be rejected.

The price adjustment will be applied to the applicable pay item for the number of cubic yards represented by the low breaks.

2. In-Place Compressive Strength.

If the Department deems it necessary, a core investigation, as described in ALDOT-457, will be performed to determine the average equivalent 28-day compressive strength of the in-place substandard concrete.

If the average equivalent 28-day compressive strength of the cores is equal to or greater than 90% of the specified 28-day compressive strength, the concrete will be accepted with no price adjustment.

If the average equivalent 28-day compressive strength of the cores is 85% or greater but less than 90% of the specified 28-day compressive strength, the concrete will be accepted with an 85% price adjustment. The price adjustment will be applied to the applicable pay item for the number of cubic yards represented by the low breaks.

If the average equivalent 28-day compressive strength of the cores is 75% or greater but less than 85% of the specified 28-day compressive strength, and the Engineer deems the concrete to be structurally acceptable, the concrete will be accepted with a 50% price adjustment. The price adjustment will be applied to the applicable pay item for the number of cubic yards represented by the low breaks.

If the average equivalent 28-day compressive strength of the cores is less than 75% of the specified 28-day compressive strength, the concrete will be rejected.

SECTION 502
STEEL REINFORCEMENT

502.01 Description.

This Section shall cover the work of furnishing and installing reinforcement steel for concrete structures in accordance with detailed plans and these Specifications.

502.02 Materials.

(a) General Requirements.

All materials shall conform to applicable portions of Division 800, Materials. Specific reference is made to Section 835, Steel Reinforcement.

Steel mesh shall be used only when and as shown on the plans.

Special attention is directed to Article 835.01 for the use of rail steel reinforcing bars in structures.

All reinforcing bars when shipped from the fabricator or supplier to the project site shall conform to the following bundling and tagging practice:

1. Bundling: All bundles shall consist of the same size bars and the same heat number.
2. Tags: Tags shall be made of durable material and marked in a legible manner with waterproof markings, not less than one tag per bundle. The tags shall show the grade, number of pieces, size, marks or length of bar, and heat number of steel.

The supplier of the reinforcing steel shall furnish to the Engineer three copies of an itemized list of all steel included in each shipment. Such list shall show the mark of the bar, bar number, heat number, grade, length, and weight {mass} of all steel for each structure requiring reinforcing steel.

(b) Bar Bending Diagrams.

When bar lists and bending diagrams are shown on the plans, the Contractor shall verify their accuracy from the drawings. Errors in the bar bending schedules and bar list shall not be cause for adjustment of contract unit prices.

502.03 Construction Requirements.

(a) General.

All reinforcement received on the project shall be placed in approved storage and shall be maintained clean, intact, and free from distortion. Reinforcement shall be free from loose or thick rust which would impair bond of the steel with the concrete. Rust that produces only discoloration without reducing the cross section of the steel will not be considered objectionable. Only such reinforcement shall be distributed along the construction as is needed for immediate use.

(b) Equipment.

All equipment necessary for the proper fabrication, bending, handling, and installation of reinforcement must be available when required, in first class working condition, and shall be approved before fabrication and construction will be permitted to begin.

(c) Handling and placing Reinforcement.

1. Bending.

Reinforcement shall be bent in accordance with CRSI Manual of Standard Practice MSP-1-97, accurately to the form and dimensions shown on the plans without heating. In bending, care shall be taken not to injure the steel and only proper appliances and competent workmen shall be employed on the work. The radius of bends shall be three or more times the diameter of the bar unless shown otherwise on the plans. Abrupt bends shall be avoided. Any reinforcement bent during shipment or handling shall be properly reshaped, without heating to a higher temperature than that producing a dark cherry-red color, before being placed in the work. Bars with kinks or bends and bars appreciably reduced in cross sectional areas shall be rejected.

2. Cleaning.

Metal reinforcement before being placed shall be cleaned of loose mill scale and of coatings of dirt, paint, oil, grease, or any other foreign substance.

3. Placing.

All reinforcing steel shall be accurately placed and firmly held in the position shown on the plans during the placing and hardening of the concrete.

A ± 1/4 inch { ± 6 mm} vertical placement tolerance will be allowed on the top mat of reinforcing steel in the bridge decks.

4. Wiring and Supporting.

a. All reinforcement shall, as elected by the Contractor, be (1) rigidly wired, or (2) if approved by the Engineer, spot welded. Suitable provision shall be made for supporting reinforcement in position during the placing of concrete. No construction operation shall be permitted which tends to bend or displace the reinforcement from its correct position. All reinforcement shall be placed and securely wired, spaced, and blocked before placing concrete in any section. Railing post reinforcement shall be installed before placing the curb concrete. In no case shall reinforcing steel be driven or forced into concrete after it has set.

b. All reinforcing metal shall be maintained at the proper distance from the forms or in the case of layers, from each layer by means of approved stays, mortar blocks, metal chairs, ties, hangers, or other approved supports.

c. Mortar blocks shall be precast from a mortar mix composed of one part Portland cement and two parts concrete sand with wires cast into them for fastening to the steel. Blocks shall be moist-cured (other curing methods may be accepted) for at least three days before use. Block basic shape shall be a square (2 inch {50 mm} x 2 inch {50 mm} Min.) with appropriate height as required to hold the steel in its designated position (+ 1/8 inch , - 0 inch {+ 3 mm, - 0 mm}). The size and shape shall be approved before use. Tie wires shall be 0.064 inch {1.6 mm} minimum diameter.

d. Metal supports shall be in accordance with CRSI Manual of Standard practice MSP-1-97 for Class 3 bar supports except that supports which are to be in direct contact with removable forms shall be Class 1 supports. Any premolded Class 1 support tips that do not provide a tight snug fit shall be rejected and removed from the work.

e. The use of pebbles, pieces of broken concrete, stone or brick, metal pipe, and wooden blocks will not be permitted.

5. Inspection.

a. Reinforcement in any member shall be placed, and then inspected and approved before the placing of concrete begins. Concrete placed in violation of this provision shall be rejected and removed at no additional cost to the State.

b. Extreme care shall be taken to insure that the final location of bars in the top of floor slabs, sidewalks, curbs, and beams are not lower than the clear distance from the top of the finished slab as shown on the plans.

(d) Splicing and Lapping Steel Reinforcement.

1. Splicing.

Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the locations and details of each splice shall be submitted by the Contractor and approved before the reinforcing steel is ordered by the Contractor. Splices shall be avoided at points of maximum stress; they shall, where possible, be staggered, and shall be designed to develop the strength of the steel without exceeding the allowable unit bond stress.

Unless otherwise shown on the plans, bars shall be lapped 24 diameters to make the splice in the slab and in the bottom of beams and girders, and not less than 35 diameters in walls, columns, haunches, and near the tops of beams and girders having more than 12 inches {300 mm} of fluid concrete under the bars.

In lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the minimum clearance distance to the surface of the concrete. Welding of reinforcing steel shall be done only if detailed on the plans or if authorized in writing. Welding shall conform to the current specifications for welded highway and railway bridges of the American Welding Society.

2. Lapping.

Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh in width.

3. Restrictive Conditions for the Welding of Reinforcing Bars.

Reinforcing bars shall not be welded unless shown otherwise on the plans or approved by the Bridge Engineer.

4. Butt Splicing.

Reinforcing bars shall be butt spliced only when shown on the plans. The butt splice shall be a mechanical coupling splice.

The mechanical coupling shall be made with a coupler that can develop, in tension, at least 125 percent of the specified yield strength (fy) of the bar. The Contractor shall prepare three test splices using the proposed method of splicing and reinforcing bars obtained from the supplier of the reinforcing steel. These test splices and two unspliced bars will be tested by the Alabama Department of Transportation's Bureau of Materials and Tests. The tension tests will be performed on full cross section specimens in accordance with ASTM E 8 {E 8M}, using a gage length that spans the extremities of the connector. Complete details of the mechanical splice and the methods and equipment proposed for use in making the splice shall be submitted to the Department for approval.

502.04 Method of Measurement.

(a) Lump Sum Unit Measurement.

The steel reinforcement required for a bridge superstructure will be measured for payment as a lump sum unit.

(b) Theoretical Unit Weight {Mass} Measurement.

The theoretical unit weight {mass} in pounds {kilograms} shall be used as the method of measurement for steel reinforcement where no other method of measurement is given for payment purposes. The weight {mass} of steel paid for shall be the number of pounds {kilograms} of steel, acceptably placed as shown to be required on the plans or as directed by the Engineer. The unit weight {mass} used for deformed bars shall be the weight {mass} of plain, square, or round bars, as the case may be, of equal nominal size. If steel mesh or expanded metal is required, the weight per square foot {mass per square meter} will be shown on the plans.

The actual quantity measured for payment will be that shown on the itemized list specified in Subarticle 502.02(a) with deductions made for:

- errors in number, size, or length of bars shipped;
- steel reinforcement used in a structure where the cost of the steel is included in the cost of the structure;
- steel reinforcement in bridge concrete superstructure units;
- discrepancies or errors in the list itself.

(c) Areas, Dimensions, and Weights {Masses}.

Area dimensions and weights {masses} to be used in calculations for the various size bars shall be as follows:

Bar Designation Number	Weight {Mass} Pounds per foot {kg / m}	Diameter inches {mm}	Cross-Sectional Area square inches {mm^2}
2	0.167	0.250	0.05
3 {10}	0.376 {0.560}	0.375 {9.5}	0.11 {71}
4 {13}	0.668 {0.994}	0.500 {12.7}	0.20 {129}
5 {16}	1.043 {1.552}	0.625 {15.9}	0.31 {199}
6 {19}	1.502 {2.235}	0.750 {19.1}	0.44 {284}
7 {22}	2.044 {3.042}	0.875 {22.2}	0.60 {387}
8 {25}	2.670 {3.973}	1.000 {25.4}	0.79 {510}
9 {29}	3.400 {5.060}	1.128 {28.7}	1.00 {645}
10 {32}	4.303 {6.404}	1.270 {32.3}	1.27 {819}
11 {36}	5.313 {7.907}	1.410 {35.8}	1.56 {1006}

(d) Splicing.

Weight {mass} allowance will be made for only those splices shown on the plans. No weight {mass} allowance will be made for splices for the Contractor's convenience.

(e) Miscellaneous Metal Parts.

1. No allowance will be made for any device, material, or method which may be used for splicing, clamping, tying, butt welding, and keeping reinforcement in proper position.

2. When the proposal form omits pay items for other metal parts indicated and required in connection with the construction of concrete structures, and compensation for such parts is not

elsewhere provided in these specifications or on the plans, the weight {mass} of such other metal parts will be included in the weight {mass} computed for steel reinforcement.

502.05 Basis of Payment.

(a) Unit Price Coverage.

Where the unit of measurement for steel reinforcement is pounds {kilograms}, the weight {mass} of steel reinforcement determined as provided above shall be paid for at the contract unit price per pound {kilogram}, which price and payment shall be full compensation for fabricating, furnishing, placing, and butt welding all materials, and for all labor, equipment, tools, and incidentals necessary to complete the Item in accordance with plan details.

The reinforcement required for a bridge superstructure shall be paid for at the contract unit price bid per lump sum for steel reinforcement for bridge superstructure which shall be full compensation for fabricating, furnishing, and placing all materials in accordance with plan details. The contract unit bid price shall also be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item of work. An increase, or decrease, in the quantity of steel reinforcement for a bridge superstructure from that shown on the plans, which is caused by a change in the plans after the contract has been let, will result in an increase, or decrease, in the compensation due the Contractor. Changes to the compensation for the superstructure reinforcing steel will be made by applying the percentage of the increase or decrease to the contract lump sum price for Pay Item 502-B, Steel Reinforcement For Bridge Superstructure.

(b) Payment will be made under Item No.:

502-A Steel Reinforcement - per pound {kilogram}
502-B Steel Reinforcement For Bridge Superstructure, ___*, ___**, ____*** - per lump sum

* Station Number, Bridge Number, Ramp Number, etc.
** Lane, if applicable
*** Approximate quantity of reinforcing steel in pounds {kilograms}

SECTION 503
STRUCTURE FOUNDATIONS

503.01 Description.

The work under this Section shall cover preparing foundations for bridges, box culverts and other miscellaneous structures.

These foundations shall be built in accordance with the details shown on the plans and the provisions provided in this Section.

503.02 Materials.

Materials used in the work required under this Section shall conform to the applicable requirements provided elsewhere in these Specifications. Members designated as mass concrete shall meet the applicable requirements found in Section 510.

503.03 Construction Requirements.

(a) General.

In the construction of foundations, it is the intent that the foundations be constructed in the dry insofar as practical. Excavation shall be in accordance with Section 214 or 215, whichever is applicable.

Where excavation is near a railroad track, the Contractor shall install such shoring and sheeting as deemed necessary by the Engineer and the Chief Engineer of the railroad company involved. Provisions of Article 107.08 shall govern.

Where the excavation is near a building, utility or other property, the Contractor shall install shoring and sheeting and perform such other work as shown on the plans for proper protection of the property, and, in addition, shall comply fully with the requirements of Article 107.12 regarding protection of property.

(b) Depth and Size of Footings.

The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

(c) Preparation of Foundations for Footings.

1. General.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped, or roughened, as may be directed by the Engineer.

Where seams, voids, cracks, or crevices exist, they shall be cleaned out and filled as directed by the Engineer. In rock, the openings shall be filled with subfooting concrete (Class A concrete) if the concrete can be placed in the dry. (Refer to Articles 503.04 and 503.05 concerning measurement and payment.) If the concrete cannot be placed in the dry, the Contractor shall propose a method for filling the openings for review and approval by the Engineer. In hard, dry material other than rock, the Engineer may allow the use of Item 214-B, Foundation Backfill, or direct the use of subfooting concrete.

When the footing is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final removal of the foundation material to grade shall not be made until just before the footing is to be placed.

2. Stable Material.

Where rock or hard foundation material is available, excavation for the footing shall be to neat lines and the concrete poured against the excavated walls without forms, unless otherwise approved by the Engineer. Concrete used to replace rock or hard foundation material excavated outside of the neat lines will not be measured for payment.

3. Unstable Material.

If the material encountered at the elevation shown on the plans for the bottom of footing is of a soft and unstable nature lacking in the required bearing value, and tests show the existence of satisfactory material of sufficient thickness and bearing value at a depth of less than 10 feet {3 m} below the elevation shown on the plans for such footing, the Engineer may order that the footing be lowered into the satisfactory material and/or that the dimensions of the footing be increased.

4. Pile Footing.

The excavation of each pit shall be completed before the piles are driven. After driving is completed, all loose and displaced material shall be so removed as to leave a smooth solid bed to receive the footing.

5. Foundation Backfill.

Foundation backfill shall be used as directed by the Engineer. Attention is directed to Section 214 or 215, whichever is applicable.

6. Adjustment in Footings.

The construction adjustments permitted above shall not be considered as materially altering the original plans and shall not be a waiver of any condition of the contract nor invalidate any of the provisions thereof.

(d) Cofferdam and Pumping.

1. General.

In the construction of footings and substructures, the item of Cofferdam and Pumping shall be used on all piers or bents where so designated on the plans. Working drawings and computations shall be submitted in accordance with Article 105.02. Attention is directed to Section 215 for piers and bents not designated to receive the item of Cofferdam and Pumping.

2. Details.

Interlocking, steel sheet piling of 3/8 inch {9.5 mm} minimum web thickness shall be used in all cofferdam work. The tops of the cofferdams shall be well above the normal water stages and their bottoms shall be carried to a depth that will prevent flow of materials into the excavation. They shall be constructed in a substantial manner, capable of resisting earth, water or concrete without appreciable displacement, distortion or leakage. Interior clear dimensions of cofferdams shall be such as will provide sufficient clearance for construction and removal of forms and for a sump outside the footing where footings are to be poured in the dry. No excess excavation and seal concrete will be paid for where the Contractor elects to use an oversized cofferdam for his convenience.

(e) Removal of Cofferdams.

Cofferdams shall not be removed until after the substructure has been constructed above normal water elevation or above the ground lines, whichever is applicable, and after the Engineer has inspected the work. Care shall be taken in removing the temporary construction so as not to damage the footings and columns. Any damage as a result of the cofferdam removal shall be replaced or repaired without additional compensation from the Department. Cofferdam sheet piling shall remain permanently in-place and undisturbed if this is shown to be required on the plans.

(f) Pumping.

All substructure concrete shall be placed in the dry unless otherwise provided on the plans. Pumping during the placing of foundation concrete shall be done from a suitable sump separated from the concrete work and shall be so conducted that there will be no water currents inside the forms or inside the excavation if no forms are required. Pumping equipment shall in all cases be of ample capacity to keep the excavation practically free of water until all the concrete is in place. Water that originates in the footing area or that is necessary to come through or across the footing area shall be handled in approved pipes or conduits to the pump sump. Cofferdams shall be dewatered for inspection purposes without additional compensation when requested.

(g) Seal Concrete.

1. General.

Seal concrete shall be used by the Contractor only when required by plan details as a structural footing or when directed by the Engineer in accordance with the following conditions. If the material encountered at the designed elevation of the bottom of the footing is so porous that water enters at such a rate that it is impractical to lower water level to this elevation by pumping, or if the material is so plastic that it cannot be prevented from flowing into the excavation by driving sheeting to reasonable depths, the Engineer may require the Contractor to seal the cofferdam with concrete. The seal concrete shall be placed in the manner prescribed in Section 501. After placement of seal concrete, the cofferdam shall not be dewatered for seven days or until concrete has, by test, indicated a compression strength of 2000 psi {14 MPa}. Immediately prior to placing seal concrete on a rock surface, the footing floor shall be cleaned by airlift or other acceptable methods. After cleaning, any mud, silt, etc., which is impossible to remove shall be agitated by means of compressed air jet so that this material will be suspended in the water during the placing of seal concrete.

All footings which are to receive seal concrete, except pile footings, will require an underwater inspection by the Department prior to placing the seal unless approved otherwise by the Engineer. The Contractor shall give at least a 48 hour notice prior to the need for an underwater inspection. The Contractor shall provide transportation to the cofferdam cell and a work station for the diver and his equipment. If the footing floor is found to be unacceptable another underwater inspection will be required after corrections are made.

2. Core Drilling of Seal Concrete Footings.

Pile footings will not be required to be cored unless noted otherwise on the plans or ordered by the Engineer. All other seal concrete footings shall be cored in accordance with the following procedure.

Cores shall be taken by the Contractor for use by the Engineer in determining the quality of the seal concrete. Two cores shall be taken if only one tremie pipe is used for the placement of the seal concrete in the footing. Four cores shall be taken if more than one tremie pipe is used for the placement of the seal concrete in the footing.

After dewatering the cofferdam, the Engineer will inform the Contractor of the location of holes to be cored in the seal concrete in each footing to determine its quality. An accurate log of cores shall be kept and the cores shall be placed in a crate and properly marked showing the footing depth and elevation at each interval of core recovery. The cores, along with three copies of the coring logs, shall be transported undisturbed to the Materials & Tests Bureau, Montgomery, Alabama, for inspection. No further concrete shall be poured inside the cofferdam until approval is received from the Construction Bureau.

Because it is necessary to obtain a high percentage of core recovery for visual inspection and compressive strength testing, the core bit used for core drilling shall be warranted by the manufacturer to be capable of coring the strength of concrete in the seal footing. The Engineer may require a new bit or replacement of the core barrel at any time inspection indicates that the equipment is incapable of coring as required. The minimum core diameter shall be 3.0 inches {76 mm}.

If the quality of the seal concrete footing is determined to be unacceptable the Engineer may require the drilling of additional cores without compensation, If the seal concrete is unacceptable the Contractor shall construct another foundation or perform corrective work as required by the Department. This foundation or the corrective work shall be constructed without compensation from the Department. The details of the replacement foundation shall be submitted in accordance with the requirements given in Article 105.02 for Working Drawings.

Unless otherwise directed by the Engineer, all footings shall be cored to a point 6 inches {150 mm} above the bottom of the seal concrete footing.

3. Mass Concrete.

Structural seal footings designated as mass concrete shall meet the requirements found in Subarticle 510.03(d) and Article 510.04.

(h) Class of Concrete.

The class of concrete required for the specific type of work involved shall be in accordance with the provisions of Section 501.

(i) Construction Joints.

In general, each footing shall be constructed as a monolith. If construction joints are required, they shall be constructed as provided in Section 501.

(j) Finish.

Concrete surfaces shall be finished in accordance with the provisions of Section 501 for Class 1 with exposed surfaces receiving a Class 2 finish unless otherwise specified by the proposal or by plan requirements.

503.04 Method of Measurement.

(a) Seal Concrete.

The measurement of the volume of seal concrete in a footing shall be calculated from the following:

L = Length of footing shown on contract plans (feet {meters});
W = Width of footing shown on contract plans (feet {meters});
T = Final approved elevation of the top of the seal footing (feet {meters});
D = Final approved elevation of the bottom of the seal footing (feet {meters});
Vs = Volume of seal concrete for which payment will be made (cubic yards {cubic meters}).
Vs = L x W x (T - D) / 27 {Vs = L x W x (T - D)}

Seal concrete outside of these limits of measurement may be required for the construction of a seal concrete footing, depending on the details of construction selected by the Contractor. No direct payment will be made for any seal concrete outside of the footing plan dimensions shown on the contract plans.

(b) Cofferdam and Pumping.

When items for cofferdam and pumping for individual piers or bents are provided by the plans and/or proposal, such will be measured in individual lump sum items for the pier or bent designated.

(c) Excavation and Backfill.

Excavation and backfill when provided by the plans, proposal, or directed will be measured and paid for under the applicable provisions of Sections 214 and 215.

(d) Core Drilling.

The actual depth of each core hole drilled at the location directed will be measured in feet {meters} to the nearest 0.1 of a foot {meter}.

(e) Subfooting Concrete.

Concrete ordered and accepted for filling voids, cracks, and crevices, as required in Item 503.03(c)1, will be measured by the cubic yard {cubic meter} delivered to the work site and acceptably placed, minus any concrete wasted.

503.05 Basis of Payment.

(a) Unit Price Coverage.

1. Seal Concrete.

Accepted seal concrete, used as directed and measured as noted above, will be paid at the contract price, which shall be full compensation for the concrete complete in place exclusive of reinforcing steel.

2. Cofferdam and Pumping.

When Cofferdam and Pumping has been provided for a designated pier or bent, the lump sum item shall be full compensation for the furnishing and installation of all material, dewatering, maintenance, removal, satisfactory clean up of the area, and for all tools, equipment, labor and incidentals necessary to complete the work.

Partial payment after installation of cofferdam will be made based on the following:

Cofferdam complete in place	80%
Excavation performed and columns poured to elevation above normal water elevation	90%
Cofferdam work complete and sheet piling removed	100%

3. Core Drilling.

Payment for the length of core drilling shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

Should the quality of the concrete be questionable based on the first cores taken from the footing, the Engineer may order additional cores to be taken from the footing. All additional coring shall be at the Contractor's expense if the footing is determined to be unsatisfactory. If the footing is determined to be satisfactory, the cost of the additional coring will be paid for at the contract unit price bid per linear foot.

4. Concrete for Rock Subfootings.

The Contractor will be paid the delivered invoice cost, minus waste and including any applicable sales taxes, to the project plus 15 percent. This price includes the concrete, gross receipt tax, labor, materials, incidentals, and the placing of the concrete in the designated locations.

(b) Payment will be made under Item No.:

503-A Seal Concrete - per cubic yard {cubic meter}
503-B Cofferdam and Pumping, Pier No. ____ or Bent No. ____ - per lump sum
503-C Core Drilling Seal Concrete Footings - per linear foot {meter}
503-E Mass Structural Seal Concrete – per cubic yard {cubic meter}

SECTION 504
STEEL PILING ENCASEMENT

504.01 Description.

The work covered by this Section consists of constructing reinforced concrete encasements on steel piling for existing bridges as shown on the plans or directed by the Engineer. The work shall include the partial removal of existing piling encasement to the limits shown on the plans, cleaning existing piling, excavation, construction of the encasements and any other incidental work or material necessary for the encasement of the piling as shown on the plans or directed by the Engineer.

504.02 Materials.

Reinforcing steel material shall be furnished in accordance with the material requirements given in Section 502.

The Contractor’s concrete producer shall establish the proportions for the concrete mix following the guidelines given in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete", and the design criteria given in this Subarticle. The concrete supplier shall submit the proposed concrete mix design to the Materials and Tests Engineer for approval following the requirements given in ALDOT-170. The distribution of approved concrete mix designs and the re-approval of concrete mix designs will be in accordance with the requirements given in ALDOT-170. Any changes

of the materials or proportions of a mix design shall be noted in a revised mix design that shall be submitted for approval.

Concrete for steel pile encasements shall meet the requirements of Class B as defined in Item 501.02(c)2 with the following exceptions:

- Type II or Type IL cement containing a maximum of 8% C3A shall be used.
- The slump range shall be from 6 inches to 8 inches {150 mm to 200 mm} during placement.

Form material shall be capable of withstanding the pressure of the placement of the concrete.

Rigid forms shall be used for the construction of the encasements. Fabric forms will not be allowed.

The epoxy mortar used to seal the forms shall be made from an approved Type I epoxy adhesive. The mix proportions of the epoxy adhesive and aggregate shall be those recommended by the manufacturer of the epoxy adhesive.

504.03 Construction Requirements.

(a) General.

The Engineer will make the final determination of whether the construction of a piling encasement should be done in either a wet or dry condition. An encasement must be constructed in the wet condition if the pile encasement site cannot be dewatered by pumps.

The required lengths of encasement shown in the listing of quantities on the Plans are approximate. The actual required lengths of encasement may vary from the approximate lengths shown on the plans.

The Contractor shall abide by the rules of navigation so as to permit the orderly passage of marine traffic at the site.

The Contractor shall repair, without compensation, all damage done to the bridge due to performance of this work.

The Contractor shall perform no work, except the pumping of the concrete, from the deck of the bridge.

Forms shall not be removed until after the concrete has cured to a compressive strength of 2500 psi {17 MPa}. All forms shall be completely removed to allow the inspection of the encasement. An unacceptable encasement shall be removed and replaced with an acceptable encasement without additional compensation.

All materials at a work site (forms, old encasement materials, swaybracing, tools, equipment, etc.) that are not required as a permanent part of the bridge structure shall be removed.

(b) Cleaning of Piling.

All steel pile surfaces to be encased shall be thoroughly cleaned of all marine growth, heavy rust, foreign materials, oil, grease, dirt, etc. Cleaning may be done either by high pressure water jet (8700 psi {60MPa} or more) or by other mechanical methods approved by the Engineer.

The Contractor shall repaint all sections of piling where paint was removed during cleaning.

(c) Placement of Steel Reinforcement.

All steel reinforcement shall be placed in accordance with plan details using non-metallic spacers to provide the required concrete cover over the reinforcing steel and pilings. All tie wires shall be turned toward the pile.

(d) Encasements Constructed in Wet Conditions.

1. Underwater Inspection.

The Department's divers will inspect the encasement work. The inspection shall be as follows:

- The Contractor shall complete all of the excavation, cleaning and placement of reinforcing steel for all of the encasements required for at least one Bent.
- At the completion of all of the excavation, cleaning and placement of reinforcing steel for all of the encasements required for at least one Bent, the Contractor shall notify the Engineer of the need for an inspection.
- The Contractor shall notify the Engineer, and the Engineer will notify the ALDOT Underwater Inspection Team Supervisor at least 48 hours prior to the need for the inspection.
- The Department's divers will also perform other inspections as needed and a final inspection of the completed encasement work.

2. Placement of Concrete.

The bottom of an encasement form shall be tightly sealed with epoxy mortar to prevent the concrete placed to fill a form from flowing out of the form. Care shall be taken to not block the bottom pumping port with the concrete or epoxy mortar seal at the bottom of a form.

The filling of an encasement form shall be done by pumping concrete through ports installed on the form. Lubricating agents placed in a pump hose shall not be pumped into an encasement form. The concrete shall be pumped until undiluted concrete is present in all areas of the encasement.

(e) Encasements Constructed in Dry Conditions.

The filling of an encasement form may be done by pumping concrete through ports installed on the form or by tremie. Lubricating agents placed in a pump hose shall not be pumped into an encasement form.

504.04 Method of Measurement.

The quantity of steel piling encasement measured for payment will be the total linear feet {meters} of encasement, measured to the nearest tenth of a foot {meter}, from the top of the encasement to the bottom, including any partial encasement where existing concrete is covered.

504.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted steel piling encasement, measured as noted above, will be paid for at the contract unit price bid per linear foot {meter} of encasement. This bid price shall include the cost of the cleaning and scarifying or partial removal of steel piling encasements, pile cleaning, excavation, concrete, reinforcement steel, forming, labor, equipment, tools, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

504-G Steel Piling Encasement, __*__ - per linear foot {meter}

* show either Wet Condition or Dry Condition.

SECTION 505
PILING

505.01 Description.

This Section shall cover the work of furnishing and driving foundation piles of the type and dimensions designated including cutting off or building up foundation piles, when required. Piling shall be furnished and installed in accordance with the requirements given in these specifications at the location, tip elevation, penetration and/or bearing shown on the plans or as directed by the Engineer.

505.02 Materials.

(a) General.

All materials shall meet the requirements specified in applicable portions of Section 834, Piling.

(b) Galvanized Piling.

1. General.

Where required on the plans, steel piles shall be hot dip galvanized. If swaybracing is used on these piles, the swaybracing will also be hot dip galvanized.

2. Surface Preparation.

The galvanizer shall pre-clean the material to be galvanized in accordance with accepted methods to produce an acceptable surface for hot dip galvanizing.

3. Shop Galvanizing.

Hot dip galvanizing of iron and structural steel shapes shall be produced utilizing lead free technology. Steel piles shall be hot dip galvanized in accordance with the latest ASTM A 123 Specification to provide a uniform minimum coating thickness of 3.5 mils (89 µm). Shop repair of coatings not meeting the above minimum thickness requirements will not be allowed.

Galvanizing practices and procedures shall protect against possible embrittlement of the steel as described in ASTM A 143.

Inspection and testing of hot dip galvanized coatings shall be done under the requirements of ASTM A 123.

The galvanizer shall supply certified test reports for the galvanized coating. These test reports shall accompany the piling manufacturer's test reports for certification of materials.

Galvanized members shall be stored, protected, handled and loaded in accordance with industry standards to protect the coating

505.03 Construction Requirements.

(a) Hammers for Driving Piles.

1. General.

Piles shall be driven with air, steam, diesel and hydraulic hammers with the exception that prestressed concrete piles 20 inches {510 mm} and larger shall not be driven with diesel hammers unless approved by the Engineer. All hammers shall be furnished with a means for adjusting the amount of energy that is delivered to the pile.

Gravity hammers will be allowed if approved in writing by the Engineer.

2. Gravity Hammers.

When gravity hammers are permitted, the ram shall weigh between 3000 and 4000 pounds {have a mass between 1360 kg and 1815 kg} and the height of drop shall not exceed 10 feet {3 m}. All gravity hammers shall be equipped with hammer guides to insure concentric impact on the drive head.

3. Steam and Air Hammers.

The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain, under working conditions, the volume and pressure specified by the manufacturer of the hammer. The plant and equipment shall be equipped with accurate pressure gages which are easily accessible to the Engineer. The weight {mass} of the striking parts of air and steam hammers shall not be less than 1/3 the weight {mass} of the drive head and pile being driven, and in no case shall the striking parts weigh {have a mass} less than 2750 pounds {1250 kg}.

4. Diesel Hammers.

Open-end (single acting) diesel hammers shall be equipped with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder to permit the Engineer to visually determine hammer stroke at all times during pile driving operations. Closed-end (double acting) diesel hammers shall be equipped with a bounce chamber pressure gauge in proper working order, mounted near ground level so as to be easily read by the Engineer.

5. Hydraulic Hammers.

Hydraulic hammers shall have a built-in monitoring system which determines the ram velocity just before impact. The contractor shall verify that the correct ram weight is entered in the monitoring system.

(b) Driving Appurtenancies.

1. Blow Count Monitoring Equipment.

Equipment shall be furnished by the Contractor for displaying the blow count rate and stroke height during driving with all hammers except gravity and double acting hammers. This equipment shall be operated at ground level to allow the Engineer to monitor the blow count rate.

2. Hammer Cushion.

Where required by the hammer manufacturer, impact pile driving equipment, except gravity hammers, shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to insure uniform driving behavior. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the hammer manufacturer's guidelines except that all wood, wire rope, and asbestos hammer cushions are specifically disallowed and shall not be used. A striker plate, as recommended by the hammer manufacturer, shall be placed on the hammer cushion to insure uniform compression of the cushion material. The hammer cushion shall be inspected in the presence of the Engineer when beginning pile driving at each structure and after each 100 hours of pile driving. A hammer cushion whose thickness has been reduced to less than 75 percent of the original thickness shall be replaced by the Contractor before driving is permitted to continue.

3. Pile Drive Head.

Piles driven with impact hammers require an adequate drivehead to distribute the hammer blow to the pile head. The drive head shall be axially aligned with the hammer and the pile. The drive head shall be guided by the leads and not be free-swinging. The drive head shall fit around the pile

head in such a manner as to prevent transfer of torsional forces during driving while maintaining proper alignment of hammer and pile.

For steel piling, the pile heads shall be cut squarely and a drive head, as recommended by the hammer manufacturer, shall be provided to hold the axis of the pile in line with the axis of the hammer.

For prestressed concrete piles, the pile head shall be plane and perpendicular to the longitudinal axis of the pile to prevent eccentric impacts from the drive head.

For special types of piles, appropriate driving heads, mandrels or other devices shall be provided in accordance with the manufacturer's recommendations so that the piles may be driven without damage.

4. Pile Cushion.

A concrete pile's head shall be protected by a wooden pile cushion. The minimum thickness placed on the pile head prior to driving shall not be less than 4 inches {100 mm}. A new pile cushion shall be provided for each pile. In addition the pile cushion shall be replaced if during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn to the extent that flame is visible. The pile cushion dimensions shall equal or exceed the cross sectional area of the pile top, and shall be appropriately sized to fit the dimensions of the pile cap.

5. Leads.

Piles shall be supported in line and position with leads while being driven. Pile driver leads shall be constructed in a manner that affords freedom of movement of the hammer while maintaining alignment of the hammer and the pile to insure concentric impact for each blow. Leads may be either fixed or swinging type. Swinging leads, when used, shall be fitted with a pile gate at the bottom of the leads. The pile section being driven shall not extend above the leads. The leads shall be adequately embedded in the ground or the pile constrained in a structural frame such as a template to maintain alignment. The leads shall be of sufficient length to make the use of a follower unnecessary and shall be so designed as to permit proper alignment of batter piles.

(c) Driving Aids.

1. General.

Driving aids such as jets, pilot holes and followers shall not be used unless either specifically permitted in writing by the Engineer or stated in the contract documents. When permitted, driving aids shall be used for installing production piles only after the pile tip elevation for safe support of the pile load is established by load testing and/or test piles driven with the same aids and methods. The Contractor shall perform, at his cost, any extra load tests and/or extra work required to drive test piles as determined by the Engineer as a condition of approval of the driving aids.

2. Jetting.

Jetting shall only be permitted if approved in writing by the Engineer or when specifically stated in the contract documents. The Contractor shall determine the number of jets and the volume and pressure of water at the jet nozzles necessary to freely erode the material adjacent to the pile without affecting the lateral stability of the final in-place pile. The jetting plant shall have sufficient capacity to permit installation to the required elevation, location, and alignment within specification tolerances. The Contractor shall decide when jetting should be discontinued above the prescribed tip elevation so that the pile will attain the required capacity at the required tip elevation established in the plans when driven with the approved hammer.

The Contractor shall control, treat if necessary, and dispose of all jet water in a manner satisfactory to the Engineer and in compliance with all regulatory guidelines.

Upon completion of jetting a pile, any voids around the pile shall be filled with clean sand and saturated with water (unless driven under water). The Contractor shall be responsible for all damage to the site caused by unapproved or improper jetting operations.

When driving concrete piles, if 240 blows per foot {300 mm} (20 blows per inch {25 mm}) is reached before the concrete pile reaches the required minimum tip elevation, then jetting may be used, when approved in writing by the Engineer, to facilitate the advancement of the concrete pile. Jetting shall be performed in a manner that allows the pile to continue on the previously established linear path of advancement by eroding the material adjacent to the concrete pile. Jetting a concrete pile may be done through internal pipes cast in the pile. Internal jet pipes shall be steel pipes for a pile that is solid concrete for the full length of the pile. Internal jet pipes shall be either steel or PVC for a pile that is cast with a void in the interior of the pile.

Once driving of the concrete pile resumes, the lowest stroke of the hammer shall be used until the Contractor and Engineer are satisfied that the original driving resistance has resumed. Under no circumstances shall driving and jetting concrete piling be allowed simultaneously.

3. Pilot Holes.

Augering, wet-rotary drilling or other methods of boring pilot holes shall be used only when approved by the Engineer or shown on the plans. When permitted, such procedures shall be carried out in a manner which will not impair the load bearing capacity of the piles already in place or the safety of existing adjacent structures. Pilot holes shall be of a size smaller than the diameter or diagonal of the pile cross section that is sufficient to allow penetration of the pile to the specified depth. If subsurface obstructions, such as boulders or rock layers are encountered, the hole diameter may be increased to the least dimension which is adequate for pile installation. The use of spuds, a short strong driven member which is removed to make a hole for inserting a pile, shall not be permitted in lieu of pilot holes.

After a pile is placed in a pilot hole the voids around the pile shall be filled with clean sand before the pile is driven. After driving, additional sand shall be added to the hole to fill the voids left by the settlement of the sand during driving. Water shall then be added to the hole to saturate the final placement of sand. Pilot holes that terminate in rock shall be backfilled to the top of the rock with substructure concrete after seating the pile. The remainder of the hole may be filled with either sand or concrete.

The Contractor shall decide when the pilot hole will be terminated above the prescribed tip elevation so that the pile will attain the required bearing capacity at the required tip elevation established in the plans when driven with the approved hammer. Where piles are to be end-bearing on rock or hardpan, pilot holes may be carried to the surface of the rock or hardpan unless otherwise noted on the plans. The piles shall then be driven with an impact hammer to insure proper seating.

If the Engineer determines that pre-excavation has disturbed the load bearing capacities of previously installed piles, those piles that have been disturbed shall be restored to conditions meeting the requirements of this specification by redriving or by other methods acceptable to the Engineer. Redriving or other remedial measures shall be instituted after pilot hole excavation operations in the area have been completed. The Contractor shall be responsible for the costs of any necessary remedial measures unless the pilot hole excavation method was specifically included in the contract documents and properly executed by the Contractor.

4. Followers.

Followers shall only be used when approved in writing by the Engineer or when specifically stated in the contract documents. In cases where a follower is permitted, the first pile in each bent and every tenth pile driven thereafter shall be driven full length, without a follower, to verify that adequate pile length is being attained to develop the desired pile capacity. The follower and pile shall be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to permit the piles to be driven to the length determined necessary from the driving of the full-length piles. The final position and alignment of the first two piles installed with followers in each substructure unit shall be verified to be in accordance with the location tolerances given in this Section before additional piles are installed.

(d) Approval of Pile Driving Hammer.

1. General.

The Contractor shall submit proposed pile driving equipment data for evaluation no less that 30 calendar days prior to the date that the equipment is proposed for use. This data shall be submitted to allow the Materials & Tests Engineer to evaluate the proposed driving equipment. The Contractor shall send the submittal directly to the Materials and Tests Engineer. The Contractor shall also send a copy of the submittal to the Engineer (Project Manager) at the same time that the submittal is sent to the Materials and Tests Engineer. The proposed driving equipment submittal shall be:

- Pile hammer operator's manuals from the hammer manufacturers.
- Completed Pile and Driving Equipment Data Form (Form C-14) for each proposed hammer.
- Charts from the hammer manufacturers shall be submitted with the data form for diesel hammers. For single acting diesel hammers, data equating stroke, blows per minute, and potential energy shall be shown on the charts. For double acting diesel hammers, data equating bounce chamber pressure to either equivalent energy or stroke of the hammer shall be shown on the charts. The measurements required for the calibration data shown on the

charts for double acting diesel hammers shall have been made no more than 90 calendar days prior to the beginning of the driving of the piles.

- If more than one hammer is submitted to drive the same size piling, the hammers shall be prioritized in the order of probable use.

Initial approval of pile driving equipment will be given by the Materials & Tests Engineer after an evaluation (usually a wave equation analysis) of the pile driving equipment data. Final approval will be based on the satisfactory performance of the equipment and successful installation of representative test piles. The representative test pile shall be the first production pile if payment for a test pile is not included in the contract. The pile driving equipment shall not be used until approval of the Engineer (Project Manager) has been given in writing.

Pile driving equipment shall be maintained in proper working condition and shall be sized so that the piles are driven with reasonable effort to the required penetration without damage.

Any change in the driving system will only be considered after the Contractor has submitted a revised Pile and Equipment Data Form for a revised wave equation analysis. The Engineer will notify the Contractor of the acceptance or rejection of the revised driving system within 7 calendar days of receipt of a revised Pile and Driving Equipment Data Form. The time required for submission, review, and approval of a revised driving system shall not constitute the basis for a contract time extension to the Contractor.

2. Wave Equation Analysis Program (WEAP).

The Department, or the Consultant Engineer provided by the Department, will perform all WEAP analyses for each pile driving hammer that the contractor may propose to use. The Department will use the information provided by the Contractor on the Pile and Driving Equipment Data Form to run a wave equation analysis. A Pile and Driving Equipment Data Form will be included in the contract documents or supplied by the Engineer.

The hammer shall be capable of driving the pile to the required tip elevation with a blow count of between 20 and 80 blows per foot or in the case of drive to refusal the blow count must be less than 20 blows/inch {25 mm} (5 blows / ¼ in {25 mm}). The tensile and compressive driving stresses shall be less than the following maximum values:

Pile Type	Maximum Allowable Compressive Stress	Maximum Allowable Tensile Stress
Steel	0.90 Fy	0.90 Fy
Prestressed Concrete	0.85 f'c – (effective prestress).	(3 times the square root of f'c) + effective prestress

The effective prestress may be obtained from the approved shop drawings.

If the hammer is approved, a blow count/bearing capacity graph with an acceptance criteria will be provided. The blowcount and hammer stroke required to achieve the required minimum bearing capacity (equal to twice the design load) will be given with the blow count/bearing capacity graph.

During pile driving operations, the Contractor shall use the system submitted and reviewed by the Department. The submitted hammer must successfully install test piles. If the hammer does not successfully install the representative piles, the Engineer will require the Contractor to repair that hammer or submit another pile driving hammer with the analyses as outlined above. No variations in the driving system will be permitted without notifying the Engineer in writing, with the exception of increasing the pile cushion thickness and reducing the energy delivered to the pile to control driving stresses. Any changes in the driving system will only be considered after the Contractor has submitted a revised Pile and Driving Equipment Data Form. If changes are made to the driving system, the Contractor shall perform a load test at no additional cost to the Department unless this requirement is waived by the Materials & Tests Engineer.

In such cases where a WEAP analysis can not be performed, a dynamic load test will be required to verify that the pile driving hammer is capable of successfully installing a representative test or production pile to the required depth without damage.

(e) Pile Driving Preparation

1. Location and Alignment Tolerance.

Piles shall be driven as nearly as possible in the exact position designated; however, a maximum deviation of 1.5 inches {40 mm} from exact position will be permissible in pile trestle bents and pile abutments, and a maximum deviation of 3 inches {75 mm} from exact position will be allowed for a foundation pile in footings of piers or abutments. Care shall be taken during driving to prevent and correct any tendency of concrete or steel piles to twist or rotate. Footings and encasements shall be

formed around the piles to give at least the minimum concrete cover shown on the plans. Piles that are to be swaybraced shall be aligned as necessary so that swaybracing can be properly welded to the piles. After all piling in a bent are aligned within the specified tolerances, the bent cap shall be placed on the piles in exact position.

If the location or alignment tolerances are exceeded, the error will be evaluated by the Bridge Engineer. The Engineer will require corrective work by either:

- stipulating what will be required by the Bridge Engineer for the corrective work or;
- requiring the submittal from the Contractor of proposed details and design calculations for the corrective work. The signature, seal, and date of signature shall be placed on all submittal details and design calculations by a Professional Engineer that is licensed in the State of Alabama and not employed by the ALDOT.

Corrective work shall not be performed until allowed by the Engineer after the Bridge Engineer has either stipulated what will be required, or has approved the Contractor's proposed repair. There will be no payment for the cost of corrective work, including the costs of submittals and delay costs.

2. Installation Sequence.

The order of placing individual piles in pile groups shall be starting from the center of the group and proceeding outwards in both directions, unless an alternate installation sequence is approved by the Engineer. If starting the installation from the center and proceeding outwards cannot be done because of battered piles, the Contractor shall submit a proposed sequence of installation to the Engineer for approval.

3. Inspection.

The Project Manager shall be given 24 hour notice before the driving of any test pile or production pile. No pile shall be driven except in the presence of a Department Inspector. An accurate driving record will be kept by the Engineer on Form C-16. Each production pile driving record will be kept by the Engineer and entered into the Engineer’s daily log book. The Test Pile Driving Record Form C-15 will be completed by the Engineer each time a test pile is driven. This form includes the number of hammer blows per foot {300 mm} for the entire driven length, the driven length, cutoff elevation, penetration in ground, driving problems, significant time delays, whether or not the test pile was dynamically monitored and any other pertinent information obtained by the Engineer. If a redrive is necessary, the Engineer will record the number of hammer blows per inch {25 mm} of pile movement.

(f) Pile Driving.

1. General.

The Contractor shall be responsible for driving piles with the approved equipment and in accordance with the procedures approved by the Engineer.

2. Test and Production Piles.

A representative test pile shall be driven in the designated location and loaded to verify the minimum bearing capacity. The minimum bearing capacity shall be verified by static testing methods. Correlation between static and dynamic test results will be required prior to using a dynamic test to verify minimum bearing capacity of other test and production piles. The correlation shall also consist of applying a dynamic restrike to the test pile within 48 hours after completion of the static load test using the approved hammer system.

The capacity determined by either test method is assumed to represent the minimum bearing capacity for each of the production piles that the test pile represents. A test pile represents a specific group of production piles that have the same size, design loading and site soil conditions. The test pile locations and the groups of production piles that each test pile represents will be shown on the plans.

Test piles shall be driven at the locations shown on the plans unless the locations are changed in writing by the Materials & Tests Engineer. Unless otherwise directed, test piles shall be driven at such locations as will permit their use in the finished structure. In no case shall test piles driven out of permanent pile locations be pulled and redriven as production piles. Test piles specified to be used as permanent piles in a structure shall have sufficient length to be cut off at plan grade for top of pile. In general, the specified length of test piles will be greater than the estimated length of production piles in order to provide for variation in soil conditions. Precast concrete test piles shall be a minimum of 10 feet {3 m} longer than the estimated length of piling shown on the plans. Steel piles shall be provided such that 10 additional feet {3 additional meters} of driving would not require an additional splice.

Upon completion of the load testing, any test or anchor piling not a part of the finished structure shall be removed or cut off at least 1 foot {300 mm} below either the bottom of footing or the finished ground elevation (if not loaded within the footing area).

The driving equipment, aids and methods used for driving test piles shall be identical to that which the Contractor proposes to use on the production piling. Approval of driving equipment shall conform with the requirements of these specifications. If piling are to be driven in a pile footing, then the Contractor shall excavate the ground at each test pile footing location to the elevation of the bottom of the footing, before the pile is driven, unless shown on the plans or directed otherwise by the Engineer.

3. Test Pile with Static Load Testing.

Test piles shall be driven to the minimum tip elevation when provided. Test piles shall be driven to a hammer blow count given on the blow count/bearing capacity graph. This graph shall be used as an estimate of the test pile's bearing capacity which uses the required minimum bearing capacity (equal to twice the design load) and stroke to obtain the required blow count for the test pile. Once the required blow count (and minimum tip elevation, when provided) is reached, the bearing capacity shall be proven (after a 7 day wait for concrete piles and a 36 hour wait for steel piles) with a Static Load Test. This blow count and stroke, or the equivalent blow count and stroke, recorded during the last foot {300 mm} of driving of a passing Static Load Test Pile shall be used as the acceptance criteria for the production piling represented by this test pile. A revised bearing graph will be provided by the Materials & Tests Engineer that reflects the actual capacity of the test pile which shall be used to determine the bearing capacity of all production piles represented by this test pile.

The Static Load Test indicates a failure if the bearing capacity determined from the load test is not equal to or greater than the required minimum bearing capacity. If the load test is a failure, the test pile shall be redriven. The blow count for the redrive shall be obtained by determining the blow count required for a theoretical increased bearing capacity. The blow count for the redrive shall be taken from the blow count/bearing capacity graph in accordance with the following formula:

$$\text{Load For Obtaining Redrive Blow Count} = [2 \times (A - B)] + A$$

A = Minimum Bearing Capacity, B = Load At Failure

The test pile shall then be reloaded. This process shall be repeated as many times as necessary until the load test is determined to be a passing load test.

Test piles driven to plan grade and not having the hammer blow count required may also be spliced and driven until the required bearing is obtained. Concrete splices must be approved by the Engineer.

4. Test Pile with Dynamic Load Testing.

Dynamic load testing may be used to supplement static load testing. All dynamic load tests shall be correlated by a minimum of one representative static load test.

If shown on the plans or in the proposal or a change is requested by the contractor and approved by the Materials and Tests Engineer, dynamic measurements will be taken by the Engineer during the driving of piles designated as dynamic load test piles.

The Contractor shall notify the Engineer when the Contractor is ready to drive a dynamic test pile seven days in advance of driving the test pile. If the Contractor changes or delays the date of the dynamic testing, then the Contractor shall pay for all costs associated with the time delay to the dynamic testing Engineer.

Test piles shall be driven to the minimum tip elevation when provided. Test piles shall be driven to the depth at which the dynamic test equipment indicates the required minimum bearing capacity (equal to twice the design load) has been achieved unless directed otherwise by the Materials and Tests Engineer. The stress in the piles will be monitored during driving with the dynamic testing equipment to insure that the values determined do not exceed the values in Item 505.03(d)2. If deemed necessary by the Engineer, the Contractor shall reduce the driving energy transmitted to the pile by using additional cushions, reducing the energy output of the hammer, or other appropriate methods in order to maintain stresses below the values in Item 505.03(b)2. If non-axial driving is indicated by dynamic test equipment measurements, the Contractor shall immediately realign the hammer system. The Engineer will notify the Contractor or their pile driving Subcontractor if their pile driving procedures violated any of the referenced requirements during the installation of the dynamically tested pile.

The Materials & Tests Engineer may use dynamic measurements to adjust tip elevations after insuring that minimum tip requirements are satisfied. The Materials & Tests Engineer will review the

dynamic test data and provide the acceptance criteria for the production piling that are represented by the test pile. A revised bearing graph will be provided by the Materials & Tests Engineer that reflects the actual capacity of the test pile which shall be used to determine the bearing capacity of all production piles represented by this test pile.

For correlation of a static load test with a dynamic load test the Contractor shall, within 48 hours of the static load test, perform a restrike dynamic load test. A cold hammer shall not be used for the restrike. The hammer shall be warmed up before restrike begins by applying at least 20 blows to another pile. The sequence shall consist of striking the designated pile for 50 blows or until the pile penetrates an additional three inches {75 mm}, whichever occurs first. In the event the pile movement is less than 1/4 inch {6 mm} during the restrike, the restrike may be terminated after 20 blows. After restrike, the Materials and Tests Engineer will either accept the tip elevation or specify additional pile penetration and testing.

5. Restrike for Production Piles

If dynamic load tests have been correlated to at least one static load test then dynamic load testing may be used to perform a re-strike to verify minimum bearing capacity of production piles.

The Materials & Tests Engineer will direct the Contractor (after waiting seven days for a concrete pile and 36 hours for a steel pile) to perform a restrike dynamic load test. A cold hammer shall not be used for the restrike. The hammer shall be warmed up before restrike begins by applying at least 20 blows to another pile. The sequence shall consist of striking the designated pile for 50 blows or until the pile penetrates an additional three inches {75 mm}, whichever occurs first. In the event the pile movement is less than 1/4 inch {6 mm} during the restrike, the restrike may be terminated after 20 blows. Dynamic load test restrike for production piles may be used to verify minimum bearing capacity of piles that fail to achieve the required blow counts determined by test pile installation and static load testing.

6. Driving to Refusal.

No test pile is required for a pile to be driven to refusal, unless shown on the plans. The only exception is when a pile will be dynamically monitored because of an inability to perform a WEAP analysis. Refusal is defined as 20 blows/inch {25 mm} (5 blows / ¼ in {25 mm}). Refusal shall only be used when rock is expected to be encountered. A load test will be required for all other situations.

7. Heaved Piles.

Level readings to check on pile heave after driving shall be made at the start of pile driving operations and shall continue until the Engineer determines that such checking is no longer required. Level readings shall be taken immediately after the pile has been driven and again after piles within a radius of 15 feet {5 m} have been driven. If pile heave is observed, accurate level readings referenced to a fixed datum shall be taken on all piles immediately after installation and periodically thereafter as adjacent piles are driven to determine the pile heave range. All piles that have been heaved more than 0.25 inches {6 mm} shall be reseated by driving to original position prior to heave. Reseating shall be done without additional compensation. Reseated piles shall be driven to the required resistance or penetration. Concrete shall not be placed in pile casings until pile driving has progressed beyond a radius of 15 feet {3 m} from the pile to be encased.

(g) Loading Methods

1. Static Load Testing Method

a. Description.

Static load testing shall be used to verify the axial load bearing capacity of pile groups or individual piles. Static load testing should be used after a test pile has been driven to the minimum tip elevation (if shown on the plans) and has met the bearing capacity estimate based on blow count and hammer stroke from the provided bearing curves. A static load test may also be used in conjunction with a dynamic load test when verifying axial load bearing capacity of piling.

b. General.

When required, the length of piles to be driven shall be determined by the actual loading tests of any designated pile (Test or Production) in the structure. The test shall be performed as defined by ASTM D 1143, Standard Test Method for Piles Under Static Axial Compressive Load using the Quick Load Test Method. In general, these tests shall consist of the incremental application and removal of static pressure exerted on the pile through approved rigging, together with suitable apparatus for accurately determining the superimposed weight {mass} of pressure and pile settlement under each increment of load. The safe allowable load shall be determined by the Engineer from the

settlement versus load curve generated by the incremental loading based on Davisson's failure criterion, explained in Subitem 505.03(g)1.c.

A minimum 7 day waiting period shall be observed between the driving of a concrete load test pile and the commencement of the load testing unless otherwise specified in the contract or authorized by the Materials and Tests Engineer. For piles other than concrete this waiting period shall be 36 hours. The Contractor may extend the waiting period as deemed necessary before performing a static load test to allow for maximum soil set up time.

If the Quick Load Test is performed using adjacent production piles as reaction piles for the test pile, the involved production piles should be checked for any permanent upward displacement. If any upward displacement is found, then all production piles used as reaction piles for the Quick Load Test shall be redriven as necessary to correct any possible axial load bearing capacity problem with the involved piles. This redrive shall be performed at the Contractor's expense.

c. Static Load Test Procedure.

The apparatus for applying the load shall be subject to the approval of the Engineer and have a capacity of 1000 tons {8900 kN} or 300 percent of the design load, whichever is less. Incremental loads of 10% of the design load shall be placed on the pile at 2.5 minute intervals until continuous jacking is required to maintain the incremental load or the capacity of the load frame is reached.

All loading tests will be continually inspected by the Engineer. Time, load, and settlement data will be recorded on Form C-15B immediately before and after the application of each load increment and at intermediate time intervals as specified. When the maximum load has been applied, readings will be taken and recorded when jacking has stopped. Additional readings will be taken after 2.5 minutes and again at 5 minutes. If a longer holding period is specified, additional readings will be taken as required. The load shall be removed after the required holding period in 4 equal parts, with time and rebound readings taken at each unloading increment. Readings will be taken immediately following each load removal, allowing 2.5 minutes between increments. Upon removal of the entire load, time and rebound readings will be taken and recorded. Additional time and rebound readings will be taken after 2.5 minutes and again at 5 minutes.

Load test data will be plotted by the Engineer in the form of settlement in inches {millimeters} (ordinate, positive down) versus applied load in kips {kN} (abscissa). Ultimate capacity predictions will be based upon Davisson's failure criterion as applied to the aforementioned settlement curve, as per FHWA's Manual on Design and Construction of Driven Pile Foundations. In this method, the elastic shortening of the pile (QL/AE, in inches {millimeters}) is superimposed on the settlement curve. In the elastic shortening equation, "Q" represents load in kips {kN}, "L" represents length of pile from settlement instrumentation to tip elevation in inches {meters}, "A" represents cross-sectional area in square inches {square meters} (at voided section, if a void is present), and "E" represents elastic modulus in ksi {MPa} (elastic modulus for concrete piles is preferably obtained from dynamic load testing, but may be calculated as 60,000 {5000} times the square root of the design compressive strength, in psi {MPa}, when dynamic load testing is not performed. The elastic modulus for steel piles may always be assumed as 29,000 ksi {200,000 MPa}).

The aforementioned elastic shortening curve is then increased or offset, by 0.15+D/120 in inches {3.81+D/120 in millimeters} (where D = pile diameter or width in inches {mm}). The point in which the offset elastic shortening curve intersects the settlement curve is considered the ultimate pile capacity.

d. Hydraulic Jacks and Load Gages.

When hydraulic jacks and gages are to be used for the superimposed load, the jacks, gages and hydraulic pumps shall have been calibrated with each other within the last 6 months by an independent laboratory that has been approved by the Materials and Tests Engineer or by a Department laboratory. If multiple jacks are to be used with one gage, the calibration shall be performed at an approved independent laboratory. All jack calibrations shall be conducted in accordance with ALDOT-358 and shall be valid for a period of 6 months from the date of calibration; however, should the Engineer have any doubt of their accuracy he may require a check of their calibration using ALDOT equipment. All calibration checks shall be within 5% of the applied load. When a jack, gage and hydraulic pump are calibrated they shall be used as a unit, and changing any one of the three components shall require a recalibration. Gages shall be of the size that will provide ease of reading (approximately 4.5 inch {115 mm} diameter) with gradations for 2 tons {18 kN} or less for loads under 100 tons {890 kN} and gradations of 5 tons {44 kN} or less for loads over 100 tons {890 kN}.

Calibrated jacks, gages and pumps shall have identifiable serial numbers to insure traceability to calibration tests.

2. Dynamic Load Testing Method.

a. Description.

Dynamic Load Testing shall be used to verify that the pile (test or production) is not overstressed while being driven and to determine the axial load bearing capacity. A Dynamic Load Test may also be used in conjunction with a Static Load Test when verifying the axial load bearing capacity of piling.

b. General.

When required, the length of piles to be driven shall be determined by the actual Dynamic Loading Test of any pile (test or production) in the structure. The test shall be performed as defined by AASHTO T 298, Standard Method of Test for High-Strain Dynamic Testing of Piles. Dynamic measurements shall be taken by the Engineer during the driving of piles designated as dynamic load test piles and/or production piles. In general, Dynamic Load Testing involves attaching two strain transducers and two accelerometers to the pile approximately 2 to 3 pile diameters below the pile head before initial driving (or at a convenient location during restrike dynamic load testing). The dynamic test is performed during actual pile driving. Dynamic load testing shall be performed, when required, on test or production piles only after a WEAP analysis has been performed.

When directed by the Engineer, the Contractor shall (after waiting seven days for a concrete pile and 36 hours for a steel pile) perform a restrike dynamic load test. A cold hammer shall not be used for the redrive. The hammer shall be warmed up before redrive begins by applying at least 20 blows to another pile or other fixed object. After redriving, the Engineer will either accept the tip elevation or specify additional pile penetration and testing.

c. Process

Prior to placement in the leads, the Contractor shall make each designated concrete pile available for taking of wave speed measurements and for predrilling the required instrument attachment holes. Since there must be room on either side of the pile to drill instrumentation holes, the Contractor may be required to move piles to attain adequate clearance. Predriving wave speed measurements will not be required for steel piles, however steel piles must be available for predrilling instrument attachment holes. When wave speed measurements are made, the piling shall be in a horizontal position and not in contact with other piling. When required, the Contractor will furnish the equipment, materials, and labor necessary for drilling holes in the piles for mounting the instruments. The instruments will be attached near the head of the pile with bolts placed in masonry anchors for concrete piles or through drilled holes on steel piles. In no case shall the pile to be dynamically tested be picked up before the pile has been predrilled.

The Contractor shall provide the Engineer with a safe, stable access to the top of the pile installed in the leads. The access shall conform to OSHA requirements. The access system shall be assembled and/or operated by the Contractor and shall provide a working area of not less than 16 square feet {1.5 square meters}. The Contractor shall furnish the Engineer details of the access system with the aforementioned Pile and Driving Equipment Data Form submittal.

The Contractor shall furnish electric power for the dynamic test equipment. The power supply at the outlet shall be 10 Amp, 115 Volt, 55-60 cycle, A.C. only. Field generators used as the power source shall be equipped with functioning meters for monitoring voltage and frequency levels.

(h) Piling Length.

1. Estimated Lengths of Piles.

The estimated length of piles shown on the plans and in the proposal are for bid purposes only. The Contractor shall be responsible for providing the lengths of these piles necessary to obtain the bearing and penetration required as determined from results obtained in driving representative test piles or other pertinent data. It is expected that there will be variations in final tip elevations due to differences in driving resistance because of differing soil conditions.

2. Pile Tip Elevation.

The final tip elevation of each pile will be determined by the Engineer during the driving operation but in general, the minimum penetration for any pile shall be not less than 10 feet {3 m} into natural ground and not less than 1/3 the length of the pile. When minimum tip elevations are specified by contract documents, the Contractor shall drive piles to a depth that satisfies this requirement in addition to required minimum bearing capacity.

3. Proposed Pile Lengths.

a. Steel Piles.

The Contractor shall furnish to the Engineer, for review, the proposed steel pile lengths for use in each bent of a structure before driving the piles.

b. Concrete Piles.

The Contractor shall furnish to the Engineer, for review, the proposed concrete pile lengths for use in each bent of a structure before casting the piles. The lengths of concrete piles will be approved by the Engineer before the casting of the piles.

(i) Unsatisfactory Piles.

Approval of a pile hammer relative to driving stress damage shall not relieve the Contractor of responsibility for the piles damaged because of misalignment of the leads, failure of the cap block or cushion material, failure of splices, malfunctioning of the pile hammer, pile manufacturer's errors, or other improper construction methods. Piles damaged for such reasons shall be rejected and replaced at the Contractor's expense when the Engineer determines that the damage impairs the strength of the pile.

The method used in driving piles shall not subject the piles to excessive or undue abuse producing crushing, cracking, or spalling of concrete or deformation of the steel. Misaligned piles shall not be forced into proper position. Any pile damage during driving by reason of internal defects, or by improper driving, or driven out of its proper location, or driven below the designated cutoff elevation shall be corrected at the Contractor's expense by a method approved by the Engineer.

Piles which have been bent during installation shall be considered unsatisfactory unless the bearing capacity is proven by load tests performed at the Contractor's expense. If such tests indicate inadequate capacity, corrective measures as proposed by the contractor and approved by the Bridge Engineer, shall be taken such as installation of additional piles, strengthening of bent piles, or replacement of bent piles.

A concrete pile will be considered defective if a visible crack or any defect is observed which, as determined by the Engineer, affects the strength or life of the pile.

(j) Splicing Piles.

1. General.

Full length piles shall be used wherever practical. When splicing is necessary and cannot be avoided, the approved method shown on the plans shall be used. If details are not shown on the plans, the contractor's proposed method of pile splicing shall be submitted to the Bridge Engineer for review and distribution.

2. Precast Prestressed Concrete Piles.

When necessary, the contractor shall submit proposed pile splicing details and design calculations to the Bridge Engineer for review and distribution. The details shall be checked, stamped approved, and signed by a Professional Engineer licensed by the Alabama Board of Licensure for Professional Engineers. This Professional Engineer shall not be an employee of the ALDOT. Any driving splice for a concrete pile will require dynamic testing during the driving to verify the performance of the splice. Payment for this requirement will be made under the item for Dynamic Loading Tests.

3. Steel Piles and Steel Shells for Cast-In-Place Concrete Piles.

Splicing of these piles shall be made in accordance with details shown on the plans or furnished. The Department has established the Miscellaneous Approved Products List which includes approved pile splicers. Information concerning this list is given in Subarticle 106.01(f) and in the Materials, Sources and Devices with Special Acceptance Requirements Manual (Qualified Products List). Only approved pile splicers shown on this list or approved by the State Construction Engineer shall be used. Welded connections for splices shall be used. All work shall be done with approved methods, materials, and experienced personnel who have been ALDOT certified 3F (qualification for fillet welding in a vertical position). Welding shall be in accordance with the Department's current Welding Specification.

Not more than three pieces (two splices) of steel pile will be permitted in making up one full length of proposed pile. Pile splices shall only be used below ground with the exception of test piles. In addition to meeting the requirements of the Specifications, the Contractor shall submit documentation of the identification (heat numbers for steel piles) of all portions of a built-up pile.

Splicer material shall be hot dip galvanized in accordance with the requirements listed in Subarticle 505.02(b) as follows:

- For above ground splices of galvanized test piles.
- For below ground splices of all galvanized piles if the plans require the piling to be galvanized down to the estimated or minimum tip elevation.

Before welding, the galvanization shall be removed from the weld area by mechanical means. Once all welding is complete, the weld area shall be cleaned and painted with a cold galvanization material from List III-1 of the Materials, Sources, and Devices with Special Acceptance Requirements Manual.

(k) Pile Points.

Pile points shall be furnished and installed as shown on the Plans or as directed by the Engineer. The type of required pile points will be designated on the Plans or by the Engineer. If pile points with cutting teeth are required it will be noted on the Plans and the Contractor shall furnish the required type of pile point with cutting teeth.

The types of pile points designated for use will be classified as follows:

- Type A-Heavy pile points.
- Type B-Light pile points.

Type A pile points may be used as a direct substitution for the Type B pile points.

The Department has established an Approved Materials List for pile points. Information concerning this list is given in Subarticle 106.01(f) and in Materials, Sources and Devices With Special Acceptance Requirements, List II-2. Only pile points shown on this list shall be used.

The pile points shall be welded to the ends of the piles in accordance with the following requirements:

- The welds for the attachment of a pile point shall be partial penetration single bevel groove welds placed full flange width along the outside of each pile flange.
- Either the pile point or the outside of each flange of the pile shall be beveled 45 degrees. The depth of the bevel shall be 3/8" minimum for HP10 and HP12 piles, and 7/16" minimum for HP13 and HP14 piles {10 mm minimum for HP250 and HP310 piles and 11 mm minimum for HP360 piles}. The width of weld at the outside face of the pile flange shall be the same as the beveled depth.
- E70XX welding rods shall be used.
- All welds shall be made in the flat position. The welder shall be ALDOT certified 1G (qualification for groove welding in flat position). Welding shall be in accordance with the Department's current Welding Specification.

(l) Cut-Off Lengths.

The tops of all permanent piles and pile casings shall be cut-off at the elevation shown on the plans or as ordered by the Engineer. All cut-off lengths not used in the structure shall become the property of the Contractor and shall be removed by the Contractor from the site of the work.

(m) Pile Painting and Protection.

All exposed surfaces of new steel piling and steel bracing members attached to the piling shall be coated after installation in accordance with the details shown on the plans and the requirements given in Section 521. The containment system and the submittal of a surface preparation plan described in Section 521 will not be required. Storage and handling of piles shall be in accordance with Article 834.11.

Field repair of galvanized coatings may be used to repair damaged areas, weld areas at pile splices, weld areas at sway braces to piles or other areas of coating damage. All field repairs shall be made in accordance with ASTM A 780. The Engineer shall be the sole judge of damaged areas that require field repair of the galvanized coating.

When galvanized members are to be field welded the Contractor shall clean the area at the weld location for a distance sufficient to provide an area free of coating for the weld metal to be deposited. The Contractor's cleaning method shall be pre-approved by the Engineer and cleaned areas shall be inspected and approved prior to field welding.

(n) Permanent Sheet Piling.

1. General.

Permanent sheet piling shall be new piling and shall be furnished and driven by the Contractor as provided on the plans or as designated by the Engineer.

2. Construction Details, Permanent Steel Sheet Piling and Concrete Sheet Piling.

All construction methods for steel sheet piling and precast concrete sheet piling shall conform to the respective requirements prescribed herein for steel and precast concrete bearing piling and as directed. Precast Concrete sheet piling may require the use of some tapered units in order to maintain vertical alignment of the sheet pile wall. Sheet piling shall be driven to the appropriate elevations. Where necessary, cutting off driven sheet piling shall be done by approved methods and in a satisfactory manner.

(o) Temporary Steel Sheet Piling.

Temporary steel sheet piling wall shall be designed, furnished and driven at the locations shown on the plans or as directed by the Engineer, and removed when no longer needed. Working drawings and design calculations for the sheet pile walls shall be submitted in accordance with the requirements given in Article 105.02 for the submittal of Working Drawings. The design shall be in accordance with the current AASHTO Standard Specifications for Highway Bridges.

The piling shall be driven to an adequate depth and/or so braced or tied back as to protect the work from damage and workmen from danger of injury and to also protect the newly constructed work from failure.

(p) Protection of Existing Structures and Utilities.

The Contractor shall control his operations to prevent damage to existing structures and utilities as outlined in Article 107.12. Preventive measures shall include, but are not limited to, selecting construction methods that will limit ground disturbance such as vibrations from pile driving operations and other construction related activities. Photographic, video and other surveys of surrounding structures and utilities could be made prior to driving to serve as documentation of the conditions prior to driving.

505.04 Method of Measurement.

(a) Test Piles.

The actual number of acceptable test piles driven as directed in conformity with these Specifications, will be measured complete in place. Piles paid for as test piles will not be included in the measurement of the linear feet {meters} of production piles. No measurement or direct payment will be made for test pile cut-offs or splices necessary to lengthen test piles.

(b) Static Loading Tests.

The number of static loading tests measured will be the actual number of accepted static loading tests ordered and completed in conformity with this Specification. If the pile does not carry the load satisfactorily after the load is placed according to the Specifications, and it becomes necessary to redrive the pile and place another load, this will be deemed an additional stage of loading. Each time the pile is driven to additional penetration and load tested again, each loading will be measured as an additional stage of loading, not as an additional loading test.

(c) Dynamic Loading Tests.

The number of dynamic loading tests measured will be the actual number of accepted dynamic loading tests ordered and completed in conformity with the specifications. There will be no additional payment for a restrike dynamic loading test performed on a designated test pile. Restrike dynamic loading tests required on production piles will be included for measurement as dynamic loading tests.

(d) Pile Points.

Pile points will be measured per each point installed on the end of an accepted pile.

(e) Steel Pile Splices.

No measurement or payment will be made for steel pile splices.

(f) Steel Piling Furnished and Driven.

The accepted lengths of steel piling furnished and driven to remain in the finished structure will be measured in linear feet, complete in place.

No measurement for payment will be made of steel pile cut-offs.

No measurement will be made for steel pile splices.

Pile cap plates, cap channels, and sway bracing will be measured and paid for as Structural Steel, per pound {kilogram}.

Piling damaged by the Contractor in handling or driving will not be accepted.

The cost of galvanizing, if required, shall be included in the pay item for steel piling. The cost of galvanizing sway bracing shall be included in the cost of the Structural Steel.

(g) Concrete Piling Furnished.

The approved lengths of concrete piling (lengths approved by the Engineer for casting) will be measured in linear feet {meters}.

(h) Concrete Piling Driven.

The approved casting lengths of concrete piling remaining in the finished structure (casting lengths minus any cut-offs) will be measured in linear feet {meters}.

(i) Concrete Pile Splice.

The build-up of a pile, where the pile will not be driven with the build-up, will be measured in linear feet {meters} from the joint at the bottom of the build-up to the top of the pile. The linear feet {length in meters} of build-up will be included in the quantity of Concrete Piling Furnished. The splicing of this build-up will be measured as 30 additional linear feet {10 additional meters} of Concrete Piling Furnished.

The build-up and splicing of a pile, where the pile will be driven with the build-up, will not be measured for payment under a contract pay item but will be paid for as Extra Work.

(j) Concrete Pile Cut-Off.

Each cut-off of a concrete pile will be measured as 6 additional linear feet {2 additional meters} of Concrete Piling Furnished.

(k) Permanent Sheet Piling.

The quantity of permanent steel or concrete sheet piling to be measured for payment shall be the quantity in linear feet {meters} of such piling actually remaining in the completed structure and accepted. In computing the linear feet {meters}, the lengths shall be those lengths under cutoffs.

(l) Pilot Holes.

Pilot holes will be measured for payment by the linear foot {meter}. Pilot Holes will be measured from the top of the material where the auger or drill begins the excavation to the bottom of the hole.

(m) Temporary Steel Sheet Piling.

Temporary steel sheet piling will be measured for payment in units of square feet {square meters}. This square foot {square meter} quantity will be determined from the length and width of individual sheet piles. The length of a sheet pile will be measured from the embedded tip to 1 foot {300 mm} above the existing ground or placed fill, whichever is appropriate. The width of a sheet pile will be the distance from centerline of the interlock on one side to the centerline of the interlock on the other side. The width of a sheet pile will be measured along the line of the sheets, not adding for bends or corrugations. The square foot {square meter} quantity for which payment will be made will be the sum of the square foot {square meter} areas of the individual sheet piles.

505.05 Basis of Payment.

(a) General.

The contract unit price bid for the various type piling covered by this Section shall be full compensation for furnishing and installing all materials required by each item of work, and for all equipment, tools, labor and incidentals necessary to complete the work. Each pay item includes fabrication, treatment, transportation, handling, driving, jetting, spudding, capping, painting and finishing where necessary and as required by other portions of the specifications and the plans. The pay item for steel piling includes the splicing and cutting off of the piles. Additional payment will be made for splicing and cutting off concrete piles. All cut-offs shall become the property of the Contractor. No payment will be made for falsework piling and no additional payment will be made for driving piles on a batter.

(b) Static Loading Tests.

Accepted static loading tests will be paid for at the contract unit price for static loading tests per each, complete in place, which shall be payment in full for all materials, equipment and labor incidental to constructing the loading platform, instrument shelter, procuring and placing the loading material, and/or equipment, and removing and disposing of the platform and material and/or equipment to the satisfaction of the Engineer.

Payment will be made for each additional stage of loading described in Subarticle 505.04(b). Payment will be the percentage of the contract price for a Loading Test given in the following table.

Design Load Shown On Plans (tons) {metric tons}	Percentage of Contract Price for a Loading Test

Up to 50 {45}	50%
Over 50 {45} to 75 {70}	75%
Over 75 {70}	100%

(c) Dynamic Loading Tests.

Accepted dynamic loading tests will be paid for at the contract unit price for Dynamic Loading Tests per each, complete in place, which shall be payment in full for all equipment and labor incidental to aiding the Engineer in the performance of this test and for all costs associated with down time while setting up equipment, making dynamic measurements, down time while waiting to perform a restrike dynamic test, and the restrike dynamic test.

(d) Permanent Sheet Piling.

The quantity of acceptable sheet piling in place after all cut-offs have been made will be paid for at the respective contract price for the type of sheet piling listed. The contract unit price bid for this item shall also include any necessary excavation unless an item of excavation is provided in the contract.

(e) Pile Points.

Pile Points will be paid for at the contract unit price per each. This payment shall be full compensation for furnishing the points and all materials, labor and incidentals necessary to install the points.

(f) Concrete Pedestal Foundations.

Where hardmarl, solid rock or other conditions are encountered that make it necessary or desirable to place piles in concrete pedestal foundations, the net length of piling so placed in the structure will be paid for at the contract unit price for the respective kinds of piling. The additional work required for construction of the pedestal foundations will be paid for as extra work as outlined in Article 104.03, Extra Work.

(g) Pilot Holes.

The contract unit price per linear foot {meter}, measured as noted above, shall be payment in full for all materials, equipment and labor required to excavate the pilot hole. It shall also be payment in full for the disposal of excavated material and for filling the voids in pilot holes around the piles with sand or concrete.

(h) Temporary Steel Sheet Piling.

The quantity of temporary steel sheet piling acceptably placed, measured as noted above, will be paid for at the unit bid price which includes furnishing the design and piling, driving, bracing, and removing the piling. The piling, after removal, shall remain the property of the Contractor.

(i) Steel Piling Furnished and Driven.

The accepted lengths of steel piling in the finished structure will be paid for at the respective contract price for steel piling furnished and driven. The extra length (beyond estimated length) of steel pile that may be required to complete a structure will be paid for at the contract price for steel piling furnished and driven. No payment will be made for cut-offs or splices of steel piling.

(j) Concrete Piling Furnished.

The approved lengths of concrete piling (lengths approved by the Engineer for casting) will be paid for at the respective contract price for concrete piling furnished.

Non-driven pile build-ups and cut-offs will be paid for at the designated rate for concrete piling furnished.

(k) Concrete Piling Driven.

The approved casting lengths of concrete piling remaining in the finished structure (casting lengths minus any cut-offs) will be paid for at the respective contract price for concrete piling driven. No payment for build-ups, either driven or non-driven, will be made under this item.

(l) Payment will be made under Item No.:

505-A Type Test Piles (*) – per each
505-B Static/Dynamic Loading Tests (*) – per each
505-E Permanent Steel Sheet Piling - per linear foot {meter}
505-F Permanent Concrete Sheet Piling (width) – per linear foot {meter}
505-G Pile Points (**) – per each
505-H Pilot Holes – per linear foot {meter}

505-I Temporary Steel Sheet Piling – per square foot {square meter}
505-M Steel Piling Furnished and Driven (*)(***) – per linear foot {meter}
505-N Concrete Piling Furnished (*) – per linear foot {meter}
505-O Concrete Piling Driven (*) – per linear foot {meter}

* Pile Designation/Size
** Type/Size of Pile Point Example: 505-G Pile Points (Type A 10”)
*** Galvanized (If Required)

SECTION 506
DRILLED SHAFT CONSTRUCTION

506.01 Description.

This work shall consist of all labor, materials, equipment and services necessary to perform all operations to complete a drilled shaft installation in accordance with these Specifications and the details and dimensions shown on the plans.

506.02 Materials.

(a) General.

All materials shall conform to requirements set forth in Division 800, Materials. The requirements provided for Structural Portland Cement Concrete, Section 501, shall apply in all respects to drilled shafts, except where otherwise indicated by specific requirements given hereinafter in this Section or noted by plan details.

(b) Concrete.

Portland cement concrete used in construction of drilled shafts shall hereinafter be referred to as either "Class DS1", "Class DS2" or "Class DS3" concrete. The specific class of concrete that is required will be shown in the Pay Item Description for Drilled Shaft Construction.

The concrete producer shall establish the proportion of materials for each class of drilled shaft concrete following the guidelines described in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete", and the criteria outlined hereinafter in this Subarticle. The concrete supplier shall submit for approval the proposed concrete mixture design to the State Materials and Test Engineer following the requirements in ALDOT-170. The distribution of the approved concrete mixture design and re-approval of concrete mixture designs will be as per ALDOT-170 respectively. Any changes of the materials and/or proportions of the mixture design will require a concrete mixture resubmittal.

1. Criteria applicable to Class DS1, Class DS2 and Class DS3 concrete:

Minimum Compressive Strength at 28 days shall be 4000 psi {30 MPa}.

The amount of cementitious material shall be a minimum of 600 pounds {360 kg} and a maximum of 800 pounds per cubic yard {475 kg per cubic meter} of concrete.

The range of total air content shall be 2.5 % to 6.0 % by volume except for concrete that is completely embedded below the ground line or mud line. An air content less than 2.5 % will be acceptable for shafts that are completely embedded below the ground line or mud line.

The maximum water to total cementitious material ratio shall be 0.40.

Slump requirements:

- The allowable range of consistency slump during concrete placement shall be from 6 inches to 9 inches {150 mm to 230 mm}.
- The minimum consistency slump for all of the concrete placed in an individual shaft shall be no less than 4 inches {100 mm} at the end of the concrete placement in that shaft.

The temperature of the concrete, at the time of placement in the shaft, shall not be less than 50 °F {10 °C} nor more than 95 °F {35 °C}.

Gradation of the coarse aggregate used shall meet the requirements for either ALDOT Size No. 57, No. 67 or No. 7.

All materials used in manufacturing the concrete shall conform to the requirements of the Specifications.

2. Additional criteria applicable to Class DS1 concrete:
Type I, Type II, or Type IL cement shall be used.
The cementitious content may be composed of up to 30% by weight {mass} substitution of either Class C or Class F fly ash additive. In lieu of fly ash, ground granulated blast furnace slag may be substituted for cement up to a minimum substitution rate of 25% and a maximum substitution rate of 50% by weight {mass}.

3. Additional criteria applicable to Class DS2 concrete:
Type II or Type IL cement containing a maximum of 8% C3A shall be used.
The cementitious content shall be composed of no less than 20% nor more than 30% by weight {mass} of Class F fly ash additive. In lieu of fly ash, ground granulated blast furnace slag may be substituted for cement up to a minimum substitution rate of 35% and a maximum substitution rate of 50% by weight {mass}.

4. Additional criteria applicable to Class DS3 concrete:
Type II or Type IL cement containing a maximum of 8% C3A shall be used.
The cementitious content shall be composed of 20% by weight {mass} of Class F fly ash and 10% by weight {mass} of microsilica additives. In lieu of the percentages of fly ash and microsilica, the cementitious content may be composed of 50% by weight {mass} substitution of ground granulated blast furnace slag and 5% by weight {mass} addition of microsilica additives.

(c) Slurry.

When use of slurry is either shown to be required in the contract documents or selected by the Contractor, mineral slurries shall be used unless another type of slurry is proposed for use by the Contractor and approved by the Engineer. The following minimum requirements apply to material components used in slurries:

1. Approved Minerals.
Sodium Bentonite or Attapulgite shall be used as the principal mineral constituents of slurry. The Engineer may approve use of other minerals upon receipt of demonstrated proof that the requested alternate mineral insures shaft stability at the applicable shaft construction site.

2. Mixing Water.
Mixing water shall be capable of meeting drinking water standards as outlined in Section 807.

3. Sand.
Clean, locally available sand meeting the requirements of Section 802 (not to exceed four (4) percent by volume) may be mixed in drilling slurries.

4. Additives.
At the Contractors discretion, additives may be used to control the consistency and/or yield of slurries subject to the limitation that the type and amount of additives used shall not exceed the recommendation(s) of the principal mineral manufacturer.

(d) Casing.

When use of casing is either specified by the contract documents or selected by the Contractor, casings shall be smooth, non-corrugated, clean, watertight steel of ample strength to withstand both handling and driving stresses and the pressures of concrete and the surrounding earth materials. Where permanent casing is required, serviceable used casing may be installed with the approval of the Engineer.

The Contractor is responsible for insuring that all casing, new or used, is capable of withstanding the aforementioned stress and pressure requirements.

(e) Steel Reinforcement.

Unless otherwise noted on the contract documents, all steel reinforcement shall be Grade 60 {420} billet steel meeting the requirements of Section 502, sized and installed in accordance with the contract plans as applicable. Welding of the reinforcing steel will not be permitted without the written approval of the Bridge Engineer. Welding to the main vertical reinforcing steel will not be permitted.

506.03 Construction Methods and Equipment.

The Contractor shall perform excavations required for shafts through whatever materials are encountered, to the dimensions and elevations shown in the plans or otherwise required by the specifications and special provisions. The Contractor's methods and equipment shall be suitable for the site conditions and materials encountered. The permanent casing method shall be used only at locations shown on the plans or authorized by the Bridge Engineer.

Actual cores recovered from the test borings are available for inspection at the Bureau of Materials and Tests.

(a) General Requirements.

1. Contractor Qualifications.

The Contractor shall submit descriptions of the drilled shaft construction projects completed in the last three years to serve as evidence of the capability to construct drilled shafts. The descriptions of the drilled shaft projects shall contain names and telephone numbers of owners' representatives who can verify the Contractor's participation on those projects. These descriptions shall be submitted with the Installation Plan and will be evaluated by the Engineer.

The evaluation of the Contractor's capability for constructing drilled shafts will have a bearing on the decision by the Engineer to require the construction of a Trial Drilled Shaft.

2. Installation Plan.

a. Installation Plan Requirements.

No later than 30 days after the date of the Notice to Proceed, the Contractor shall submit an installation plan for review by the Engineer. This plan shall provide information on the following items as applicable:

- Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations for this project;
- List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies, concrete pumps, casing, etc.;
- Details of the overall anticipated construction operation sequence and the proposed sequence of shaft construction;
- Details of planned shaft excavation methods;
- Details of the methods to be used to insure shaft stability (i.e. prevention of caving, bottom heave, etc., using temporary casing, slurry or other means) during excavation and concrete placement. This shall include a review of method suitability to the anticipated site and subsurface conditions. If casings are proposed or required, casing dimensions and detailed procedures for permanent casing installation, and temporary casing installation and removal shall be provided.
- When use of slurry is required or proposed, details of the methods for mixing, circulating and desanding slurry;
- Details of methods to clean the shaft excavation;
- Details of reinforcement placement including support and centralization methods;
- Details of concrete placement method required or proposed including operational procedures for free fall, tremie or pumping as appropriate; and
- The method used to fill or eliminate all voids between the plan shaft diameter and excavated shaft diameter, or between the shaft casing and surrounding soil, if permanent casing is specified.
- Details of the material, equipment, and procedures proposed to accomplish the required load testing.

b. Evaluation of Installation Plan.

The Engineer will evaluate the drilled shaft installation plan for conformance with the plans and specifications. Within 15 days following receipt of the installation plan, the Construction Engineer will return the plan for corrections, distribute the plan for construction inspection, or contact the Contractor to establish a mutually agreeable date and time for a meeting to discuss the installation plan. If a meeting is held to discuss the installation plan the Contractor and his drilled shaft project superintendent shall be in attendance. The Contractor will be notified of changes in the submitted installation plan deemed necessary by the Construction Engineer within seven days after the aforementioned meeting. Shaft construction shall not begin until the installation plan has been distributed by the Construction Engineer for construction inspection. Distribution of the installation plan for construction inspection shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed on the plans and in the specifications.

c. Modification of Installation Plan.

Any proposed modification of the installation plan during construction shall be submitted to the Construction Engineer for review and distribution.

3. Protection of Existing Structures and Utilities.

The Contractor shall control his operations to prevent damage to existing structures and utilities as outlined in Article 107.12. Preventive measures shall include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, monitoring and controlling the vibrations from construction activities such as the driving of casing or sheeting, drilling of the shaft, or from blasting, if permitted.

4. Construction Sequence.

a. Excavation to the bottom of shaft elevation shall be completed before shaft construction begins unless otherwise noted in the contract documents or approved by the Engineer. Any disturbance caused by shaft installation to a planned drilled shaft area shall be repaired by the Contractor prior to the shaft construction.

b. When drilled shafts are to be installed in conjunction with embankment placement, the Contractor shall construct drilled shafts after the placement of fills unless shown otherwise in the contract documents or approved by the Engineer.

c. Substructure concrete shall not be placed on a drilled shaft until the concrete in the shaft reaches a minimum of 80% of the required 28-day compressive strength and until all CSL test results (when required) are accepted and the CSL tubes have been dewatered and grouted.

(b) Methods of Construction.

1. Dry Method.

The dry construction method shall be used only at sites where the groundwater level and soil conditions are suitable to permit construction of the shaft in a relatively dry excavation, and where the sides and bottom of the shaft may be visually inspected by the Engineer prior to placing reinforcement and concrete. The dry method consists of drilling the shaft excavation, removing accumulated water and loose material from the excavation, placing the reinforcing cage, and concreting the shaft in less than 3 inches of water.

2. Wet Method.

The wet construction method may be used at sites where a dry excavation can not be maintained for placement of the shaft concrete. This method consists of using water or mineral slurry to maintain stability of the hole perimeter while advancing the excavation to final depth, placing the reinforcing cage, and concreting the shaft. Where drilled shafts are located in open water areas, exterior casings shall be extended from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. The casing shall be installed in a manner that will produce a positive seal at the bottom of the casing so that no seepage of water or other materials occurs into or from the shaft excavation.

3. Casing for Dry or Wet Construction Methods.

Permanent or temporary casing may be used when shown on the plans or at sites where the dry or wet construction methods are inadequate to prevent caving or excessive deformation of the hole. In this method the casing may be either placed in a predrilled hole or advanced through the ground by twisting, driving or vibration before being cleaned out. Casing which is going to be installed by predrilling and permanently left in rock for the purpose of shielding voids, shall be installed in not more than a 2 inch {50 mm} oversized drill hole. When downsizing of permanent casing is required, no more than six feet of overlap of casing will be allowed.

When the casing method is required but not shown on the plans, the Contractor shall submit details of the proposed casing method (including casing lengths and diameters) and the proposed procedures of casing installation to the Bridge Engineer for review in the installation plan. If the need is determined after work on the shafts has begun, a revised plan proposing this method must be submitted for review.

(c) Excavation Procedures.

1. Excavation Location, Coordination and Time Constraints.

Shaft excavations shall be made at locations and to the elevations, geometry and dimensions shown in the contract documents or as directed by the Engineer.

A shaft shall not be excavated as long as an adjacent shaft in the same substructure unit is open unless authorized in writing by the Construction Engineer. Blasting and vibrating casings in place will

not be allowed until the concrete in adjacent shafts has reached 80 % of the required 28-day compressive strength.

Once the excavation of a shaft has been started, the excavation shall be conducted in a continuous operation until the excavation is completed.

When an excavation is performed with any type of drilling fluid (i.e. slurry, water, etc.) used to stabilize the excavation, the placement of concrete shall begin within 36 hours from the start of excavation and within 12 hours from the start of the excavation of the bottom 5 feet {1.5 m} of the shaft. If the Contractor exceeds these time limits, additional work may be required to insure that the condition of the excavation is adequate to result in an acceptable load carrying capacity in the completed drilled shaft. The Contractor may be required to over ream the entire depth of excavation (or the bottom 5 feet {1.5 m} if the 12 hour time limit is exceeded), increase the depth of the excavation or perform other work that may be required by the Engineer to provide an acceptable excavation. There will be no compensation for this additional work.

The minimum width of over reaming shall be 1/2 inch {13 mm} and the maximum width shall be 3 inches {75 mm}.

2. Excavation Log.

The Contractor shall maintain an excavation log during shaft excavation. The log shall contain information such as: the description and approximate top and bottom elevation of each soil or rock material encountered during shaft excavation, elevations at which seepage or groundwater flow are encountered, and remarks. The type of tools used for the excavation shall be shown on the log. All changes in the type of tools used for excavation shall be shown on the log. The Engineer will monitor these operations and the logs will be used as a basis of measurement for payment. The Contractor shall resolve all discrepancies on the log noted by the Engineer at the end of each work day. Two copies of the legible, final log shall be furnished to the Engineer within 24 hours after a shaft excavation is completed and accepted.

3. Handling Excavated Material.

Excavated materials which are removed from shaft excavations shall be disposed of by the Contractor in accordance with Subarticle 215.03(g).

4. Excavation Safety.

The Contractor shall not permit workers to enter the shaft excavation for any reason unless: suitable casing has been installed, the water level has been lowered and stabilized below the level to be occupied, and adequate safety equipment and procedures have been provided to protect workers entering the excavation. The Contractor is responsible for compliance with applicable State and Federal safety regulations.

(d) Types of Drilled Shaft Excavation.

1. Drilled Shaft Excavation.

The excavation of the shaft using conventional earth drilled shaft excavation tools will be designated as "drilled shaft excavation".

2. Special Drilled Shaft Excavation.

The excavation of the shaft requiring rock tools and/or procedures to accomplish hole advancement will be designated as "special drilled shaft excavation". This excavation will be for the removal of rock or other hard material within the planned shaft.

(e) Excavating and Drilling Equipment.

1. General.

Excavation and drilling equipment shall have adequate capacity including power, torque and down thrust to excavate a hole of both the maximum specified diameter and to a depth of twenty (20) percent beyond the depths shown on the plans when operated at rated capacity.

2. Rock Tools and Equipment.

When the material encountered cannot be drilled using conventional earth drilling tools and equipment, the Contractor shall provide rock drilling equipment including air tools, approved blasting materials, and other equipment as necessary to construct the shaft excavation to the size and depth required. Concurrence of the Engineer shall be obtained prior to switching from earth to rock drilling tools and equipment. Approval of the Engineer is required before excavation by blasting is permitted.

3. Overreaming.

a. Sidewall overreaming shall be required when the sidewall of the hole is determined to have either softened due to excavation methods, swollen due to delays in concreting, or degraded because of slurry cake buildup. Overreaming thickness shall be a minimum of 1/2 inch {13 mm} and a maximum of 3 inches {75 mm}.

b. Overreaming may be accomplished with a grooving tool, overreaming bucket or other approved equipment. The thickness and extent of sidewall overreaming shall be as directed by the Engineer. The Contractor shall bear all costs associated with both sidewall overreaming and additional shaft concrete placement.

4. Lost Tools.

Drilling tools which are lost in the excavation shall not be considered obstructions and shall be promptly removed by the Contractor without compensation. All costs due to lost tool removal shall be borne by the Contractor including costs associated with correcting hole degradation due to removal operations and time delays.

(f) Exploratory Shaft Excavation.

1. General.

The Contractor will be required to perform some type of exploratory shaft excavation (soil samples, rock cores or drilling or probing) below the bottom elevations shown on the plans unless this requirement is noted on the plans as being deleted. The Contractor shall extend drilled shaft tip elevations when the Engineer determines that the material encountered during this exploratory excavation is unsuitable and/or differs from that anticipated in the design of the drilled shaft.

2. Rock Cores and Soil Samples.

The Contractor shall take 2.0 inch {51 mm} minimum diameter rock cores and/or soil samples at locations as designated on the plans or as directed by the Engineer to determine the character of the material directly below the completed shaft excavation. The soil samples shall be extracted with a split spoon sampler or undisturbed sample tube in accordance with AASHTO T 206 and T 207. The methods and equipment used for the rock coring shall be those given in Subarticle 506.10(b) for the core drilling of drilled shaft concrete. The cores and/or soil samples shall be taken to a minimum of 10 feet {3 m} below the bottom of the drilled shaft excavation unless otherwise noted on the plans or directed by the Geotechnical Engineer. The Engineer may require this depth to be extended up to a total depth of 20 feet {6 m} below the bottom of the shaft. The Contractor may choose to take these cores and/or soil samples prior to excavating for the drilled shafts, however, payment will only be considered for that portion of the cores taken below the bottom elevation of the shafts shown on the plans.

Rock core and soil test samples shall be measured, visually identified and described on the Contractor's log. The samples shall be placed in suitable containers, identified by shaft location, elevation and project number and delivered to the Central Laboratory in Montgomery with the Contractor's field log within 24-hours after the exploration is completed. The Engineer will inspect the samples/cores and determine the final depth of required excavation based on his evaluation of the sampled materials suitability.

3. Drilling or Probing.

At all drilled shaft locations where rock cores and/or soil samples are not designated, the Contractor will be required to drill or probe an exploratory hole below the bottom elevation of the shaft to determine if any voids or crevices are present. The exploratory hole shall be taken to a depth of 10 feet {3 m}, unless noted otherwise on the plans. Exploratory drilling or probing will not be required if it is noted on the plans that this requirement is not necessary. No direct payment will be made for this operation.

(g) Obstruction Removal.

Surface and subsurface obstructions at drilled shaft locations shall be removed by the Contractor. Such obstructions may include man-made materials such as old concrete foundations and natural materials such as boulders. Special procedures and/or tools shall be employed by the Contractor in the event the hole cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets and/or underreaming tools. Special procedures/tools may include but are not limited to: chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the hole diameter. Blasting shall not be permitted unless specifically approved in writing by the Engineer. Removal of obstructions will be classified as "special drilled shaft excavation".

(h) Trial Drilled Shaft Installation.

1. General.

The Engineer will require the construction of a trial shaft if the submittal of descriptions of previous drilled shaft construction projects does not, in the opinion of the Engineer, substantiate the Contractor's capability for constructing the drilled shafts on this project. The Engineer may also require the construction of a trial shaft to verify the adequacy of unusual construction methods and/or equipment proposed for use in the construction of the production shafts.

The trial drilled shaft shall be constructed if required by special note on the plans.

2. Location and Depth.

The trial shaft(s) shall be positioned as indicated on the plans or as directed by the Engineer. Unless otherwise indicated, shafts shall be drilled to the maximum depth of any production shaft shown on the plans.

3. Failure to Demonstrate Ability.

Failure of the Contractor to demonstrate the adequacy of his equipment, methods and/or expertise shall be reason for the Engineer to require alterations necessary to eliminate unsatisfactory results. Additional trial shafts required to demonstrate correction of deficiencies shall be at the Contractor's expense.

4. Trial Shaft Approval.

Once approval has been given to construct production shafts, no changes will be permitted in the personnel, methods or equipment that were used to construct the satisfactory trial shaft without written approval of the Engineer.

5. Site Restoration.

Unless otherwise shown in the contract documents, the trial shaft holes will be filled with non-reinforced concrete in the same manner that production shafts will be constructed. The concreted trial shafts shall be cutoff 2 feet {600 mm} below finished grade or at the mudline if in water. The disturbed areas at trial shaft holes shall be restored as nearly as practical to their original condition. No direct payment will be made for cutting off the top of the trial shaft or for the site restoration.

506.04 Encased Excavations.

(a) General.

The outside diameter of casings shall not be less than the specified shaft size. No extra compensation will be allowed for concrete required to fill an oversized casing or excavation. All casings, except permanent casing, shall be removed from shaft excavations.

(b) Temporary Casing.

1. General.

All casing shall be considered temporary unless specifically shown as permanent casing in the contract documents. The Contractor will be required to remove temporary casing before completion of concreting the drilled shaft. Telescoping, predrilling with slurry, and/or overreaming to beyond the outside diameter of the casing may be required to install casing.

2. Size Substitution.

If the Contractor elects to remove a specified diameter or length of casing and substitute a longer or larger diameter casing through caving soils, the excavation shall be either stabilized with slurry or backfilled before the new casing is installed. Other methods, as approved by the Engineer, may be used to control the stability of the excavation and protect the integrity of the foundation soils.

3. Bound or Fouled Casings.

Temporary casings which become bound or fouled during shaft construction and cannot be practically removed shall constitute a defect in the drilled shaft. The Contractor shall be responsible for correcting such defective shafts to the satisfaction of the Engineer. Correction may consist of, but is not limited to: removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. All corrective measures including redesign of shafts caused by defective shafts shall be done to the satisfaction of the Engineer without compensation or an extension of the completion date of the project. In addition, no compensation will be paid for casing remaining in place.

4. Removable Casing.

When the shaft extends above ground or through a body of water, the portion exposed above ground or through a body of water may be formed with suitable, removable casing except when permanent casing is specified. Removable casing shall be stripped from the shaft in a manner that will not damage the concrete. Casings can be removed when the concrete has attained a compressive strength of not less than 2500 psi {20 MPa} as determined from concrete cylinder breaks provided: curing of the concrete is continued for the full period in accordance with specifications and the shaft concrete is not exposed to salt water or moving water for seven days.

(c) Permanent Casings.

1. General.

Permanent casing shall be used when shown in the contract documents. The casing shall be continuous between top and bottom elevations prescribed in the plans. After installation is complete, the permanent casing shall be cut off at the prescribed elevation and the shaft completed by installing necessary reinforcing steel and concrete in the casing.

Exterior surfaces of permanent casings shall be cleaned and coated with the prime coat only of a System 1A Coating in accordance with the requirements given in Section 521 and as shown on the plans. The exterior surfaces shall be coated prior to the installation of the casings. After the installation of the casings, all damage to the coated surfaces of the casings exposed to the air shall be repaired by a repeated application of the same prime coat. When not shown in the contract documents, permanent casing may be used if determined to be necessary by the Engineer and if approved by the Bridge Engineer.

2. Multiple Casings.

In cases where special temporary casings are shown on the plans or authorized in writing by the Engineer, the Contractor shall maintain alignment of both the temporary outer and permanent inner casing, and a positive, watertight seal between the two casings during excavation and concreting operations.

506.05 Use of Slurry.

(a) General.

Slurries shall have a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain stability of the excavation and allow proper concrete placement.

(b) Mixing and Storage.

The mineral slurry shall be premixed thoroughly with clean fresh water and adequate time allotted for hydration prior to introduction into the shaft excavation. Slurry tanks of adequate capacity will be required for slurry circulation, storage, and treatment. Excavated slurry pits will not be allowed in lieu of slurry tanks without the written permission of the Engineer.

(c) Desanding.

Desanding equipment shall be provided by the Contractor as necessary to control slurry sand content at less than 4 percent by volume at any point in the borehole. Desanding will not be required for setting temporary casing, sign post, or lighting mast foundations unless required by the plans or special provisions.

(d) Required Fluid Level.

1. General.

During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry in the hole, the construction of that foundation shall be stopped until methods to stop slurry loss or an alternate construction procedure have been approved by the Engineer.

2. Required Head.

Mineral slurry in a shaft excavation shall be maintained at a level not less than 4 feet {1.2 m} above the highest expected static water surface along the depth of the shaft. If at any time the Engineer determines the slurry construction method fails to produce the desired final results, the Contractor shall discontinue this method and propose an alternate method for approval of the Engineer.

(e) Control of Slurry.

1. Setup Prevention.

The Contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include but are not limited to: agitation, circulation and/or adjusting the properties of the slurry.

2. Control Testing.

Control tests using suitable apparatus shall be carried out on the mineral slurry by the Contractor to determine density, viscosity and pH. An acceptable range of values for these physical properties is shown in the following table:

MINERAL SLURRY (Sodium Bentonite or Attapulgite in Fresh Water) Acceptable Range of Values			
Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density (pounds per cubic foot) {kg/m^3}	64.3** – 69.1** {1030** – 1110**}	64.3** – 75.0** {1030** – 1200**}	Density Balance
Viscosity (seconds / quart) {seconds / liter}	28 – 45 {30 – 48}	28 – 45 {30 – 48}	Marsh Cone
pH	8-11	8-11	pH paper, pH meter
** Increase by 2 pounds per cubic foot {32 kg/m^3} in salt water			
a. Tests should be performed when the slurry temperature is above 39 °F. b. If desanding is required, sand content shall not exceed 4 percent (by volume) at any point in the bore hole as determined by the American Petroleum Institute sand content test.			

(f) Testing of Slurry.

1. Frequency.

Tests to determine density, viscosity and pH value shall be done during the shaft excavation to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first 8 hours of slurry use. When the results show consistent behavior the testing frequency may be decreased to one set every four hours of slurry use.

2. Test Reports.

Reports of all tests required above, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft.

(g) Disposal.

All slurry and contaminated spoils shall be captured and contained to the maximum extent practicable. All slurry and contaminated spoils shall be disposed offsite by the Contractor or as directed by the Engineer.

506.06 Excavation Measurement and Cleaning.

(a) General.

The Contractor shall provide equipment and personnel for checking the dimensions and alignment of each permanent shaft excavation. The dimensions, depth and alignment shall be determined under the direction and to the satisfaction of the Engineer after final cleaning.

(b) Cleaning.

Unless otherwise stated in the contract, a minimum of 50 percent of the base of each shaft will have less than 1/2 inch {13 mm} of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1.5 inches {40 mm}. Shaft cleanliness will be determined by visual inspection for dry shafts. For wet shafts the bottom of the shaft shall be sounded with an airlift pipe, a tape with a heavy weight {mass} attached to the end of the tape or other means acceptable to the Engineer. In addition, for dry excavations the maximum depth of water covering the bottom of the excavation shall not exceed 3 inches {75 mm} prior to concrete pour.

506.07 Reinforcing Steel Construction and Placement.

(a) General.

The reinforcing steel cage, consisting of longitudinal and transverse bars, ties, cage stiffeners, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement. The reinforcing steel in the shaft shall be securely tied and supported so that the reinforcing steel will remain within allowable tolerances given in Subarticle 506.11(c) of this Specification.

(b) Spacers.

1. Concrete spacers or other approved noncorrosive spacing devices shall be used at sufficient intervals near the bottom, and at intervals not exceeding 10 feet up the shaft, to insure concentric spacing for the entire cage length.

2. Spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the shaft. The spacers shall be of adequate dimension to insure the proper annular space between the outside of the reinforcing cage and the side of the excavated hole and/or permanent casing as detailed on the plans or proposed in the installation plan. If not detailed on the plans, a minimum 4 inch {100 mm} annular space will be required.

(c) Cage Supports.

Cylindrical concrete feet (bottom supports) shall be provided to insure that the bottom of the cage is maintained at the proper distance above the base as specified by the project plans.

(d) Cage Extension.

If the drilled shaft excavation is extended to an elevation lower than the plan bottom elevation, reinforcing cage length shall also be extended by the same amount. Cages may be extended at the plan bottom elevation by lap splicing additional longitudinal bars, per planned cage requirements, of sufficient length to provide a compression splice, 4.17 feet {1270 mm} in length, plus the required extension. Hoops for the extension shall be spaced the same as shown for other hoops. Any additional splices of the cage above the plan bottom elevation and not shown on the plans, must have prior approval of the Bridge Engineer. Stiffeners, spacers and other appurtenances shall also be extended as required.

506.08 Concrete Placement Requirements.

(a) General.

Concrete used for drilled shaft construction shall meet the requirements of Subarticle 506.02(b).

After the reinforcing steel has been placed and before the concrete is ordered, the bottom of the drilled shaft must be resounded to verify cleanliness.

(b) Concrete Placement Time Limitations.

1. General.

Concrete shall be placed as soon as possible after the reinforcing steel has been placed and the bottom of the shaft has been resounded. The concrete placement shall be continuous from the bottom to the top elevation of the shaft.

The elapsed time from the beginning of concrete placement in the shaft to the completion of placement shall not exceed 2 hours except as allowed by the Engineer. The Engineer may allow the concrete placement time to exceed 2 hours if the Contractor adequately demonstrates that the slump of the concrete will not be less than 4 inches {100 mm} during the entire time of concrete placement.

2. Slump Loss/Time Relationship.

a. General.

The Contractor may choose either a laboratory test or a field test to demonstrate the slump loss/time relationship. Adjustments to chemical admixture dosages will be allowed for the sole purpose of extending the time of concrete placement provided that the admixtures are included in the approved concrete mix design. A new slump loss test will be required if changes are made to the concrete mix, including adjustments to chemical admixtures.

b. Laboratory Test.

The Contractor shall demonstrate by trial mix and slump loss tests that the slump of the concrete will not be less than 4 inches {100 mm} during the longer placement time. These tests shall be conducted by an independent testing laboratory, approved by the Department as per ALDOT-405, and in the presence of a Department representative. The slump loss tests shall be performed at

intervals not to exceed 30 minutes and shall be made from a trial mix proportioned from the approved concrete mix design. The temperature of the trial mix shall be kept at a level representative of construction site conditions.

c. Field Test.

The Contractor shall demonstrate by construction site slump loss tests that the slump of the concrete will not be less than 4 inches {100 mm} during the longer placement time. The slump loss tests shall be performed at intervals not to exceed 30 minutes and shall be made from the first batch of concrete that is placed in a trial drilled shaft. The concrete used for these slump loss tests shall be sampled at the trial drilled shaft site and shall be kept covered during testing. If a trial shaft is not required then a field test may be performed at the construction site prior to the beginning of the work. The slump test shall be performed by the contractor's Concrete Technician, certified by the Department as per ALDOT-405, in the presence of a Department representative.

(c) Placement through Slurry and/or Encased Excavations.

1. General.

The Contractor shall insure that a heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft.

2. Required Slurry Sampling.

Prior to placing concrete in a slurry filled shaft excavation, the Contractor shall take slurry samples using a sampling tool. Slurry samples shall be extracted from the base of the shaft and at intervals not exceeding 10 feet {3 m} up the shaft, until two consecutive samples produce acceptable values for density, viscosity, pH, and sand content as noted in Subarticle 506.05(c) and Item 506.05(e)2, respectively.

3. Unacceptable Sampling Results.

When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Concrete shall not be poured until resampling and testing results produce acceptable values.

4. Required Concrete Level During Placement.

The level of fresh concrete placed into a casing shall be a minimum of 5 feet {1.5 m} above either the hydrostatic water level or the level of drilling fluid whichever is higher. As a temporary casing is withdrawn, care shall be exercised to maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the shaft concrete.

506.09 Concrete Placement Methods.

(a) General.

If a method of concrete placement has not been specifically identified in the contract documents, the Contractor may use any of the placement methods described hereafter. If a concrete pump is used to move the concrete to the drilled shaft, a standby pump shall be immediately available to pump the concrete if there is a pump failure. Details pertaining to compliance with this specification shall be presented as part of the Contractors "Installation Plan" as outlined in Item 506.03(a)2.

Concrete placement shall continue after the shaft excavation is full until good quality concrete is evident at the top of the shaft. Any overflow of concrete at the top of the shaft shall be removed to maintain a uniform appearance and the proper dimensions of the shaft.

(b) Free Fall Placement.

1. General.

The free fall placement of concrete shall only be permitted in dry vertical shafts where the clear opening (inside the reinforcing cage) is not less than 24 inches {610 mm} in diameter. The height of free fall placement shall not exceed 75 feet {22 m}. Concrete placed by free fall shall fall directly to the placement location without contacting either the reinforcing cage or the shaft sidewall.

The Engineer will observe the falling of the concrete within the shaft. If the concrete strikes the reinforcing cage or sidewall, or if there is excessive spatter from the impact of the falling concrete, the Contractor shall reduce the rate of concrete placement, reduce the height of free fall or provide a drop chute for concrete placement as directed by the Engineer.

2. Drop Chute Requirements.

a. General.

Drop chutes shall consist of a smooth tube of either one piece construction or sections which can be added and removed. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement.

b. Chute Support.

The drop chute shall be supported so that the free fall of the concrete measured from the bottom of the chute to the point of deposition is less than 75 feet {22 m}. If concrete placement causes the shaft excavation to cave or slough, or if the concrete strikes the rebar cage or sidewall, the Contractor shall reduce the height of free fall and/or reduce the rate of concrete flow into the excavation.

3. DISQUALIFICATION OF FREE FALL METHOD.

If in the opinion of the Engineer, placement cannot be satisfactorily accomplished by the free fall and drop chute method, the Contractor shall change to either tremie or pumping methods to accomplish the pour.

(c) Tremie Concrete Placement.

Tremies may be used for concrete placement in either wet or dry holes.

1. Tremie Requirements.

a. General.

Tremies shall consist of a tube of sufficient length, weight {mass}, and diameter to discharge concrete at the shaft base elevation. The tremie shall not contain aluminum parts which will have contact with the concrete. The tremies inside diameter shall be at least 6 times the maximum size of aggregate used in the concrete mix but shall not be less than 10 inches {250 mm}.

b. Tremie Tube Wall.

Inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends which restrict concrete placement.

c. Concrete Placement.

The tremie used for wet concrete placement shall be watertight. Underwater placement shall not begin until the tremie is placed to the shaft base elevation. Valves, bottom plates or plugs may be used to insure concrete discharge begins within one tremie diameter of the base. Plugs shall either be removed from the excavation or be made of a material which will not cause a defect in the shaft if not removed. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations.

2. Placement Requirements.

a. General.

The tremie discharge end shall be immersed at least 5 feet {1.5 m} in concrete at all times after starting the flow of concrete. The flow of the concrete shall be continuous. The concrete in the tremie shall be maintained at a positive pressure differential at all times to prevent water or slurry intrusion into the shaft concrete.

b. Defective Shafts.

If at any time during the concrete pour, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the Contractor shall either:

- remove the reinforcing cage and concrete, complete any necessary sidewall removal directed by the Engineer, and repour the shaft or,
- the tremie shall be replugged, recharged with concrete and inserted a minimum of 5 feet {1.5 m} below the existing top level of concrete prior to continuing the pour. The contractor shall be responsible for correcting any defect caused by this procedure without additional compensation.

All costs for replacement of defective shaft concrete shall be the responsibility of the Contractor.

(d) Pumped Concrete Placement.

Concrete pumps and lines may be used for concrete placement in either wet or dry excavations.

1. Equipment Requirements.

Pump lines shall have a minimum diameter of 4 inches {100 mm} and shall be constructed with watertight joints. Except as modified herein, requirements pertaining to tremie lines as stated in Item 506.09(c)1, also apply to pump lines and their use. The concrete pump unit shall have sufficient power to insure continuous placement of concrete under all foreseeable placement conditions.

2. Placement Requirements.

a. Discharge Orifice Location and Pressure.

The discharge orifice shall remain at least 5 feet {1.5 m} below the surface of the fluid concrete. When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation.

b. Defective Shafts.

If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall removal directed by the Engineer, and repour the shaft. All costs for replacement of defective shaft concrete shall be the responsibility of the Contractor.

506.10 Testing Requirements For Drilled Shafts.

(a) Crosshole Sonic Logging of Drilled Shafts.

1. General Requirements.

The nondestructive testing method called Crosshole Sonic Logging (CSL) shall be used on all production and trial drilled shafts (a) when constructed with the placement of concrete underwater or through slurry, (b) when required by special note on the plans, (c) when a full length temporary casing is used to prevent water from entering the shaft, or (d) when determined to be necessary by the Engineer. The testing shall not be conducted until 72 hours after the placement of all concrete in a shaft and must be completed within 20 calendar days after placement.

The CSL tests shall be conducted by an experienced independent testing consultant approved by the Engineer prior to testing.

The CSL tests measure the time it takes for an ultrasonic pulse to travel from a signal source in one access tube to a receiver in another access tube. In uniform, good quality concrete, the travel time between equi-distant tubes will be relatively constant and correspond to a reasonable concrete pulse velocity from the bottom to the top of the foundation. In uniform, good quality concrete, the CSL test will also produce records with good signal amplitude and energy. Longer travel times and lower amplitude/energy signals indicate the presence of irregularities such as poor quality concrete, void, honeycomb and soil intrusions. The signal will be completely lost by the receiver and CSL recording system for the more severe defects such as voids and soil intrusions.

2. Preparation for Testing.

A number of tubes shall be installed in each shaft to permit access for CSL. The number of tubes installed will depend on the diameter of the shaft as specified below:

Shaft Diameter D	Minimum Number of Tubes
D $\leq$ 4.5 feet {1372 mm}	4
4.5 feet {1372 mm} < D $\leq$ 5.5 feet {1676 mm}	5
5.5 feet {1676 mm} < D $\leq$ 6.5 feet {1981 mm}	6
6.5 feet {1981 mm} < D $\leq$ 7.5 feet {2286 mm}	7
7.5 feet {2286 mm} < D $\leq$ 8.5 feet {2591 mm}	8
8.5 feet {2591 mm} < D $\leq$ 9.0 feet {2743 mm}	9
9.0 feet {2743 mm} < D $\leq$ 10.0 feet {3048 mm}	10
10.0 feet {3048 mm} < D $\leq$ 11.0 feet {3353 mm}	11
11.0 feet {3353 mm} < D $\leq$ 12.0 feet {3658 mm}	12

The tubes shall have a 1.5 inch {40 mm} inside diameter and shall be schedule 40 steel pipe. The pipes shall have a round, regular internal diameter free of defects or obstructions, including any at pipe joints, in order to permit the free, unobstructed passage of a 1.3 inch {30 mm} diameter source and receiver probes. The tubes shall be watertight and free from corrosion with clean internal and external faces to ensure passage of the probes and a good bond between the concrete and the tubes.

The pipes shall each be fitted with a water tight shoe on the bottom and a removable cap on the top. The pipes shall be securely attached to the interior of the reinforcement cage with a minimum

cover of 4 inches {100 mm}. The tubes shall be installed in each shaft in a regular, symmetric pattern such that each tube is equally spaced from the others around the perimeter of the cage. The Contractor shall submit to the testing organization his selection of tube size, along with his proposed method to install the tubes, prior to construction. The tubes shall be as near to parallel as possible. The tubes shall extend from 6 inches {150 mm} above the shaft bottoms to at least 3 feet {1 m} above the shaft tops. If the shaft top is sub-surface, the tubes shall extend at least 2 feet {600 mm} above the ground surface. Any joints required to achieve full length tubes shall be made watertight. Care shall be taken during reinforcement installation operations in the drilled shaft hole so as not to damage the tubes. As the cage is being lowered into the shaft, the tubes shall be checked to assure that they are vertical and parallel and that all connections are water tight. After placement of the reinforcement cage, the tubes shall be filled with clean water as soon as possible. After the tubes are filled with water, the tube tops shall be capped or sealed to keep debris out of the tubes prior to concrete placement.

The pipe caps or plugs shall not be removed until the concrete in the shaft has set. Care shall be exercised in the removal of caps or plugs from the pipes after installation so as not to apply excess torque, hammering, or other stresses which could break the bond between the tubes and the concrete.

3. Typical CSL Test Equipment.

Typical CSL test equipment consists of the following components:

- A microprocessor based CSL system for display of individual CSL records, analog-digital conversion and recording of CSL data, analysis of receiver responses and printing of CSL logs.
- Ultrasonic source and receiver probes for 1.5 inch {40 mm} ID pipe, as appropriate.
- An ultrasonic voltage pulser to excite the source with a synchronized triggering system to start the recording system.
- A depth measurement device to determine and record depths.
- Appropriate filter/amplification and cable systems for CSL testing.

4. CSL Logging Procedures.

Before the placement of concrete, a minimum of one tube per shaft shall be plumbed and the tube length recorded, including a notation of the stickup of the tubes above the shaft tops. Information on the shaft bottom and top elevations and/or length, along with construction dates shall be provided to the Engineer and the approved testing organization before the CSL tests are performed.

The CSL tests shall be carried out with the source and receiver probes in the same horizontal plane unless test results indicate potential defects in which case the questionable zone may be further evaluated with angled tests (source and receiver vertically offset in the tubes). CSL measurements shall be made at depth intervals of 2 inches {50 mm} or less, and shall be done from the bottom of the tubes to the top of each shaft. The probes shall be pulled simultaneously, starting from the bottoms of the tubes, over a depth measuring device. Any slack shall be removed from the cables prior to pulling to provide for accurate depth measurements of the CSL records.

Prior to leaving the job site, the approved testing organization shall notify the Engineer that all data was collected satisfactorily or if there were discrepancies in the supplied CSL tube lengths, difficulties in obtaining the data or if tube access was obstructed anywhere in the supplied lengths. CSL tests shall be conducted between pairs of tubes. The approved testing organization shall test at least two diagonals through the center and between each tube pair around the perimeter of all tested shafts. Two diagonal tests shall be as close as possible to being at right angles to each other. Additional logs shall be conducted at no additional cost in the event anomalies are detected.

The Contractor shall attempt to clear all tube obstructions reported to the Engineer so that tubes can be retested to full depth while the approved testing organization is on site. If obstructions cannot be cleared in a tube the approved testing organization shall conduct the CSL test in the adjacent pair of unobstructed tubes so that the measurements are made as close as possible to the obstructed tubes.

Any anomalies indicated by longer pulse arrival times and significantly lower amplitude/energy signals shall be reported to the Engineer and further tests such as fan shaped tests, tests with probes raised at a fixed offset distance, or other topographical techniques shall be conducted as required to evaluate the extent of such anomalies. Additional NDT methods which may be used to evaluate possible defects include Singlehole Sonic Logging, Gamma-Gamma Nuclear Density Logging, and/or Surface Sonic Echo and Impulse Response tests.

5. CSL Testing Results.

The CSL results shall be presented to the Engineer in a report. This report shall include recommendations as to the acceptability, unacceptability, soundness, etc., of the drilled shaft. The report shall be checked, stamped approved, and signed by a Professional Engineer licensed by the Alabama Board of Licensure for Professional Engineers. This Professional Engineer shall not be an employee of the ALDOT. The report shall be submitted directly to the Materials and Tests Engineer with a copy to the Project Manager. The test results shall include CSL logs with analyses of:

- Initial pulse arrival time versus depth
- Pulse energy/amplitude versus depth

A CSL log shall be presented for each tube pair tested with any defect zones indicated on the logs and discussed in the test report as appropriate.

6. Evaluation of CSL Test Results.

The Engineer will evaluate the CSL test results and determine whether or not the drilled shaft construction is acceptable. This evaluation will be completed within 14 calendar days of the date of receipt of the report by the Materials & Tests Engineer.

If the Engineer determines that the drilled shaft is acceptable, the CSL tubes shall be dewatered and grouted. The grout shall be of the same strength or higher than the strength of the concrete used in the original drilled shaft. The contractor may use any of the grout mixes listed in Table 1 of Item 453.03(b)2. with the exception that calcium chloride will not be allowed. The contractor may submit another design mix for approval.

If the Engineer determines that the drilled shaft is unacceptable, the shaft shall be cored in accordance with the requirements given in Subarticle 506.10(b) to allow further evaluation of the shaft. Cores shall be taken without additional compensation unless the testing of the cores indicates that the concrete in the shaft meets all specification requirements. If the testing of the cores indicates that the concrete meets specification requirements, the cost of the coring will be paid for as Extra Work.

(b) Core Drilling Of Drilled Shaft Concrete.

Production or trial drilled shafts that are determined to be unacceptable by the CSL tests may be cored to determine the quality of the shaft. The required number and depth of cores will be determined by the Engineer.

Because it is necessary to obtain a high percentage of core recovery for visual inspection and compressive strength testing, the core bit used for core drilling shall be warranted by the manufacturer as being capable of coring the concrete as strong as could possibly be present in the shaft. A new bit or new core barrel will be required at any time the Engineer determines that the equipment may not be capable of obtaining good quality cores. The minimum diameter of the cores shall be 3.0 inches {76 mm}.

An accurate log of cores shall be kept and the cores shall be placed in a crate and properly marked showing the shaft depth at each interval of core recovery. The cores along with three copies of the coring log shall be transported to the ALDOT Bureau of Materials and Tests, Montgomery, Alabama, for inspection.

Construction shall not proceed above a drilled shaft until the quality of the shaft, as represented by the core samples, is determined to be acceptable and notification to continue construction is given by the Construction Engineer.

If the Engineer determines that the drilled shaft is acceptable, the core holes and the CSL tubes shall be dewatered and grouted. The grout shall be of the same strength or higher than the strength of the concrete used in the original drilled shaft. The contractor may use any of the grout mixes listed in Table 1 of Item 453.03(b)2. with the exception that calcium chloride will not be allowed. The contractor may submit another grout design mix for approval.

If the quality of the drilled shaft is determined to be unacceptable then the Contractor shall construct another foundation to carry the load that will be placed on the shaft or perform corrective work as required by the Department. This foundation or the corrective work shall be constructed without compensation from the Department. The details of the replacement foundation shall be submitted in accordance with the requirements given in Article 105.02 for Working Drawings.

506.11 Drilled Shaft Construction Tolerances.

The following construction tolerances apply to drilled shafts unless otherwise stated in the contract documents. Drilled shaft excavations and completed shafts not constructed within the required

tolerances are unacceptable. The Contractor shall correct all unacceptable shaft excavations and completed shafts to the satisfaction of the Engineer. Materials and work necessary to complete corrections for out of tolerance drilled shaft excavations and/or completed shafts, including engineering analysis and redesign, shall be furnished without either cost to the State or an extension of the contract time of the project.

(a) General Location.

The drilled shaft shall be within 3 inches {75 mm} of plan position in the horizontal plane at the elevation of the top of the shaft.

(b) Vertical Alignment.

The vertical alignment of a shaft excavation shall not vary from the plan alignment by more than 1/4 inch per foot {20 mm/m} of depth. The alignment of a battered shaft excavation shall not vary by more than 1/2 inch per foot {40 mm/m} of depth from the prescribed batter.

(c) Reinforcing Steel Cage.

The spacers for the reinforcing cage shall have a tolerance of minus 1 inch {25 mm} from the required spacing shown on the plans.

The reinforcing steel cage shall be within 1 inch {25 mm} of plan position in the horizontal plane at the elevation of the top of the shaft.

After all the concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches {150 mm} above and no more than 3 inches {75 mm} below plan position.

(d) Casings.

All casing diameters shown on the plans refer to OD (outside diameter) dimensions. Casing shall be clean, round, straight and free of weld breaks and/or holes that would permit passage of water or wet concrete. When approved by the Engineer, the Contractor may elect to provide a casing larger in diameter than shown in the plans. No payment will be made for additional construction materials used in accommodating the Contractor's request for a larger casing diameter.

(e) Shaft Socket.

The diameter of an excavated socket shall have a tolerance of minus 2 inches {50 mm} from the plan diameter.

(f) Top Elevation of Shafts.

The top elevation of the shaft shall have a tolerance of plus 1 inch {25 mm} or minus 3 inches {75 mm} from the plan top of shaft elevation.

(g) Excavation Equipment and Methods.

Excavation equipment and methods shall be designed so that the completed shaft excavation will have a planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of +/- 3 % of the diameter.

506.12 Method of Measurement.

(a) Drilled Shaft Excavation.

Drilled shaft excavation will be measured by the linear foot {meter} of excavated shaft.

(b) Special Drilled Shaft Excavation.

Special drilled shaft excavation will be measured by the linear foot {meter} of excavated shaft.

(c) Drilled Shaft Construction.

Drilled shaft construction will be measured by the linear foot {meter} of shaft.

(d) Exploration Below Drilled Shaft.

The exploratory drilling below the bottom of a drilled shaft will be measured by the linear foot {meter} of core hole.

(e) Permanent Drilled Shaft Casing.

Permanent drilled shaft casings will be measured by the linear foot {meter} of casing left in place.

(f) Crosshole Sonic Logging (CSL).

Testing by the CSL method will be measured per each shaft tested.

506.13 Basis of Payment.

(a) Drilled Shaft Excavation.

The linear foot {per meter} bid price shall be full compensation for all labor, materials and equipment required to complete and support the excavation. This shall also be full compensation for the utilization of slurry and temporary casings, for the disposal of all surplus excavated materials and for incidentals necessary to complete the work. No additional payment will be made for larger diameter or deeper excavations that are made by the choice of the Contractor.

(b) Special Drilled Shaft Excavation.

The linear foot {per meter} bid price shall be full compensation for all labor, materials and special equipment required to complete and support the excavation. This shall also be full compensation for the removal of obstructions, the utilization of slurry and temporary casings, for the disposal of all surplus excavated materials and for incidentals necessary to complete the work. No additional payment will be made for larger diameter or deeper excavations that are made by the choice of the Contractor.

(c) Drilled Shaft Construction.

The linear foot {per meter} bid price shall be full compensation for all labor, materials, equipment and incidentals required for the construction of a shaft except for reinforcing steel which will be paid for under Item 502-A. No additional compensation will be made for larger diameter or deeper shafts that are constructed by the choice of the Contractor.

(d) Exploration Below Drilled Shaft.

The linear foot {per meter} bid price shall be full compensation for all labor, materials, equipment and incidentals required for coring and sample retrieval.

(e) Trial Drilled Shaft.

Payment for a trial drilled shaft will be made under the appropriate production drilled shaft items of 506-A, B, C, F or G as they may apply. No separate payment will be made for cutting off the trial shaft or site restoration.

(f) Permanent Drilled Shaft Casing.

The linear foot {per meter} bid price shall be full compensation for all labor, materials, equipment and incidentals required for furnishing, painting and installing the casing. No payment will be made for cutoffs.

If there is no pay item in the contract for permanent casing then the casing will be paid for as extra work as outlined in Article 104.03, Extra Work.

(g) Crosshole Sonic Logging.

The price bid for each shaft tested shall be full compensation for all labor, materials, equipment and incidentals necessary to perform the required test and furnish the Engineer with the test results. The bid price shall also include dewatering the tubes and filling the tubes with grout.

Where a drilled shaft consists of different shaft diameters, the price bid shall be full compensation for the sonic logging of the complete depth of the drilled shaft, regardless of differences in the diameter of the shaft. The shaft diameter shown in the pay item for sonic logging is for identification purposes and will be the smallest diameter portion of a drilled shaft.

(h) Payment will be made under Item No.:

506-A Drilled Shaft Excavation, __*__ Diameter - per linear foot {meter}
506-B Special Drilled Shaft Excavation, __*__ Diameter - per linear foot {meter}
506-C Drilled Shaft Construction, __*__ Diameter, Class __**__ Concrete - per linear foot {meter}
506-D Exploration Below Drilled Shaft - per linear foot {meter}
506-F Permanent Drilled Shaft Casing, __*__ Diameter – per linear foot {meter}
506-G Crosshole Sonic Logging, __*__ Diameter - per each

* Specify diameter of shaft in feet and inches {millimeters}.
** Specify either “DS1”, “DS2” or “DS3”.

SECTION 507
ABUTMENT AND BULKHEAD ANCHORS

507.01 Description.

This Section shall cover the work of furnishing and installing complete abutment and/or bulkhead anchor assemblies for precast concrete bridges, timber bridges, and/or timber, metal, or concrete bulkheads, all in accordance with the details shown on the plans and at the locations shown on the plans or directed. Special reference is made to Section 510, Bridges.

507.02 Materials.

All materials shall comply with the appropriate requirements of Division 800, Materials, and the following:

Unless otherwise noted or provided by plan details, all miscellaneous hardware (turnbolts, clamps, bolts, etc.) shall be new galvanized metal, galvanized in accordance with AASHTO M 232.

Wire rope (cable) for rope anchor assemblies shall be of 3/4 inch {19 mm} nominal diameter. Wires shall meet the requirements of ASTM Designation A 475 "Siemens Martin" grade having a Class A galvanization coating or an approved equal.

Galvanizing of materials completely encased in concrete will not be required.

Precast-Prestressed members of anchor assemblies shall comply with the appropriate requirements for precasting and prestressing concrete as noted in Sections 501 and 834.

507.03 Construction Requirements.

All anchor assemblies shall be erected in accordance with the details shown on the plans or directed.

Fabrication of integral parts of an anchor assembly shall be in accordance with the requirements of other appropriate sections of the Specification for the type material involved with specific reference made to Sections 833, 834, 835, and 836.

507.04 Method of Measurement.

An anchor assembly for an abutment shall consist of the number of sets of tieback cables or arms designated on the plans to connect an abutment to the anchors and includes the connecting system of fastening the cables or arms to the anchors and the abutment. Only one assembly will be measured for each abutment regardless of the number of anchors attached to the abutment.

An anchor assembly for a bulkhead shall consist of the number of sets of tieback cables or arms designated on the plans to connect a section of a bulkhead to one anchor and includes the connecting system of fastening the cables or arms to the anchor and bulkhead. A separate assembly will be measured for each anchor attached to a bulkhead.

The anchors will be measured and paid for under the appropriate item of piling designated for use as the anchors.

The abutment or bulkhead will be measured and paid for under the appropriate item(s) of which the abutments or bulkheads are constructed.

507.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted anchor assemblies, measured as noted above, will be paid for at the contract unit price per each which shall be full compensation for furnishing all materials along with the installation of the anchor assemblies, complete in place, attached to the anchor(s) and the abutment or bulkhead, and includes all incidental excavation, backfill, and compaction thereof, miscellaneous hardware, etc., and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

507-A Wire Rope Abutment/Bulkhead Anchor Assembly - per each

507-B Prestressed Concrete Abutment/Bulkhead Anchor Assembly - per each

SECTION 508
STRUCTURAL STEEL AND MISCELLANEOUS METALS

508.01 Description.

The work under this Section shall cover the furnishing, fabricating, erecting, and painting (both shop and field) all structural steel and metal work. All work shall be in conformity with the dimensions, shapes and designs shown on the plans. Erected materials shall conform to lines and grades shown on the plans.

Structural metals covered in this Section shall include structural steel shapes (except piling) and plates, bolts, and other types of fasteners, welding, special and alloy steels, steel forgings and castings, and all types of metal casting as well as any incidental metal construction not covered in other Sections.

Welding of structural steel and other metals shall conform to the requirements of Article 836.46 and any modification thereto provided in the contract.

Applicable requirements of Sections 510 and 521 shall also apply to this Section.

Issues concerning non-conforming work, repair procedures, requests for variances and/or clarification of Contract plans and/or Specifications including approved shop drawings shall be addressed by submitting ALDOT Bridge Bureau form BBF-15 “Request for Approval” (RFA) to the State Bridge Engineer for review and approval along with any supporting documentation.

508.02 Materials.

All materials shall conform to the provisions of Division 800, Materials, specific reference is made to the following:

Section 836 - Structural Steel, Fasteners and Miscellaneous Metals.
Section 855 - Coatings, Paints, Enamels, and Varnishes For Metal and Wood Structures.

Except where otherwise provided, all members shall be of structural carbon steel.

Pipe or tubing for railing shall be as specified on the plans.

Forgings shall be of carbon steel and shall be annealed before machine finishing.

Castings shall be made of the type metal specified by the plans, but in general, cast iron shall be used only for unimportant parts.

High strength steel fasteners shall conform to the requirements of Article 836.33. High strength steel lock-pin and collar fasteners will not be permitted unless noted in the plan details.

Materials for bridge deck drainage systems shall conform to the requirements shown on the plans. Galvanizing, if required, shall conform to ASTM A 120 for pipe, AASHTO M 111 for forgings, shapes, etc., AASHTO M 232 for miscellaneous hardware and anchor bolt assemblies (anchor bolts, nuts, and washers), and ASTM B 695 Class 50 for bolt assemblies (bolts, nuts, and washers).

508.03 Construction Requirements.

(a) General.

Attention is directed to the requirements of Sections 105 and 836 concerning approval of "drawings", "mill orders and shipment statements," and "notice and facilities for inspection" before fabrication of structure members.

All exposed structural steel surfaces, including piling, not in contact with concrete shall, unless otherwise noted by the plans or proposal, be painted in accordance with the provisions of Section 521 utilizing green bridge paint for the top coat (or other color as specified by plans). The painting of the steel and the cost thereof is considered incidental to the furnishing of the structural steel.

When a structure utilizing AASHTO M 270 Grade 50W (weathering) steel is designated to be unpainted, the steel shall be cleaned after fabrication (includes drilling and reaming) in accordance with the provisions of Steel Structures Painting Council specification SSPC-SP-6.

All foreign material which adheres to the steel after fabrication, including tight mill scale, shall be removed without additional compensation. Tight mill scale on the top of the top flanges of girders and beams may remain except in the locations where studs are to be attached. The surface of the steel shall be cleaned to bright metal just prior to attaching studs.

All temporary markings shall be removed before the final acceptance of the structural steel.

(b) Shop Fabrication.

The requirements for shop fabrication are given in Section 836.

Within 30 days after the award of the contract, the Contractor shall submit the following items to the Bridge Engineer:

- Name, address and location of the plant where the structural steel will be fabricated.
- A current copy of the fabricator's American Institute of Steel Construction Certification including Fracture Critical Endorsement (FC) or Sophisticated Paint Endorsement (SPE) where required.
- A written statement naming the ALDOT III-1 coating system that will be applied to the structural steel.
- Construction survey data if this is shown to be required on the plans.

The review of the shop drawings, and the time allowed for the review given in Section 105, will not begin until all of the required items have been received by the Bridge Engineer. Additional evidence of the fabricator's qualifications and experience shall be furnished if requested by the Bridge Engineer.

No material shall be fabricated before the Department has been notified where the fabrication order has been placed. The Fabricator is responsible for notifying the Bridge Engineer of any outsourced work to be done by another facility, the name and address of the outside source, and the proposed schedule.

Shops fabricating main structural steel members (as defined by Subarticle 836.01(b)) and/or items paid for under Pay Item 508-B (with the exception of navigational light brackets, inspection catwalks, platforms and ladders) shall be certified by the American Institute of Steel Construction. These facilities shall conform to the AISC Certification Program for Steel Bridge Fabricators for either Intermediate Bridge or Advanced Bridge depending on the complexity of the structure by design for all steel bridges. For fracture critical work, shops shall be certified for either Intermediate Bridge or Advanced Bridge with the fracture critical endorsement.

Shops fabricating expansion dams (finger joints, etc.) for interior and exterior bridge joints shall be certified by the AISC Certification Program for Bridge and Highway Metal Component Manufacturers or by the Intermediate AISC Bridge Certification program for steel bridge fabrication.

Shops producing miscellaneous steel bridge items (other than those described above) shall be qualified to do such work by placement on the ALDOT List I-9: Producers of Inlet Grates and Seats for Drainage Structures and Miscellaneous Fabricated Bridge Items.

For the purpose of ALDOT Quality Assurance inspection and scheduling a completed ALDOT Bridge Bureau Form BBF-11 shall be submitted to the Bridge Engineer stating the tentative schedule for fabrication no less than 45 days in advance of the actual fabrication of 508B pay items and no less than 7 days for 508A pay items.

(c) Storage.

All material shall be stored in such manner as to prevent corrosion or loss of minor parts. It shall be placed on skids or dunnage a minimum of 1 foot {300 mm} above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored (no welding). Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. All storage and storage sites are subject to the approval of the Engineer. Reference is made to Articles 109.07 and 836.17.

(d) Erection.

1. Working Drawings.

Working drawings outlining a procedure and the equipment to be used for erection of all continuous span steel units, trusses, and other metal work requiring field splices shall be submitted for distribution in accordance with Article 105.02. If any falsework is to be used as part of the steel erection procedure, the drawings and design calculations. shall be submitted along with the erection procedure.

If temporary bracing is used on any type of steel girder to stabilize the girder the details and design of the bracing shall be submitted as working drawings in accordance with the requirements given in Article 105.02.

Falsework shall be designed and constructed to withstand all imposed loads during erection, construction, usage, and removal. The State Construction Engineer will verify that the licensed Professional Engineer signature and stamp requirements of Subarticle 105.02(d) are met. Steel Girder erection drawings will be reviewed by the State Construction Engineer and will be forwarded to the Bridge Engineer for review to determine if the results of the licensed Professional Engineer's calculations are in compliance with design criteria. If the design criteria are met, the submittal will be returned to the State Construction Engineer to be stamped for distribution and then distributed.

All falsework and temporary bracing will be inspected by the Project Manager using the distributed drawings. For all falsework used in connection with steel girder erection, the licensed

Professional Engineer who signed the falsework submittal shall visually verify that the falsework as constructed meets all design criteria prior to any load being placed thereon. A signed statement from the licensed Professional Engineer covering the verification shall be furnished to the Project Manager by the Contractor.

2. Bearings and Anchorage.

a. Uniform Bearing Surface.

Bridge bearings shall be set level in exact position and shall have a full and even bearing on the masonry and shall not be placed on masonry bearing areas which are irregular or improperly formed.

b. Bedding Material Required Under Rocker Bearings.

Where rocker bearings are used, filler or fabric materials, meeting the following, shall be placed as bedding material under masonry plates.

Such material shall be of the type specified or as ordered or approved by the Engineer and shall be installed to provide full bearing on contact areas.

Immediately before placing the bedding material and installing bearings or masonry plates, the contact surfaces of the concrete and steel shall be thoroughly cleaned.

Preformed fabric pads used as bedding shall be composed of multiple layers of 8 ounce per square yard {271 g/m^2} cotton duck impregnated and bonded with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The thickness of the preformed fabric pads shall be 3/16 inch ± 1/16 inch {5 mm ± 2 mm}. Cotton duck shall meet the requirements of Military Specification MIL-C882-D for 8 ounce per square yard {271 g/m^2} cotton army duck or equivalent. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 psi {69 MPa} without detrimental reduction in thickness or extrusion.

Sheet lead used as bedding shall be common desilverized lead conforming to ASTM B 29. The sheets shall be of uniform thickness and shall be free from cracks, seams, slivers, scale, and other defects. Unless otherwise specified, lead sheets shall be 1/8 inch {3 mm} in thickness with a permissible tolerance of 0.03 inch {0.75 mm} plus or minus.

c. Vertical Positioning of Rocker Bearings.

Rocker bearings shall be adjusted so that they will be in vertical position at an ambient temperature of 70 ° F {20 °C}.

d. Installation of Masonry Plates.

Masonry plates for self-lubricating bronze bearing plates or PTFE coated bearing plates shall be set 1/2 inch {13 mm} (minimum) into the cap in Portland cement mortar not more than 3/4 inch {19 mm} thick and the depression filled with mortar so that no water will be trapped. No superstructure or other load shall be placed thereon until this mortar has been allowed to set for at least 96 hours in a well moistened condition throughout this period. Prior to erecting girders, the top plate shall be rotated to fit the grade of the girder and the bearing plate shall be adjusted for temperature so that it will be centered on the masonry plate at 70 °F {20 °C}.

e. Anchor Bolt Installation.

The reinforcing steel in the concrete shall be adjusted as directed by the Engineer prior to pouring in order to permit the correct placement of the anchor bolts.

If the required details of the anchor bolt installation are not given on the plans the Contractor shall have the following options for installing the bolts:

- supporting the bolts with a template during the placement of concrete;
- casting anchor bolt wells in the concrete;
- drilling holes in the concrete after the concrete has cured.

The Contractor shall notify the Engineer in writing of the option selected for the installation of the bolts.

Anchor bolt wells shall be large enough to allow adjustments to the location of the bolts to fit adjustments to the superstructure unit but shall not exceed 4 inches {100 mm} in diameter unless approved otherwise by the Bridge Engineer. The form for the anchor bolt wells shall be removed before wells are filled. Water shall not be allowed to enter the wells or the drilled holes. Freezing water may crack the concrete.

If anchor bolt wells are used, a 4000 psi {28 MPa}, 28 day compressive strength Portland cement grout mix, or a proprietary non-shrink grout mix shall be used to fill the wells. If anchor bolts are installed in drilled holes, a 4000 psi {28 MPa}, 28 day compressive strength Portland cement grout

mix, a proprietary non-shrink grout mix or an approved epoxy adhesive shall be used to fill the wells. The grout shall not be placed until after the superstructure unit has been erected and adjusted. A description of the grout mix (Portland cement or proprietary) shall be submitted to the Materials and Tests Engineer for approval prior to installation of the anchor bolts.

f. Location of Anchor Bolts.

Anchor bolts shall be located as shown on the plans and shall be set vertical to the plane of the bridge bearing seat. Anchor bolts required at expansion bearings shall be installed so that the centerline of the anchor bolt aligns with the center of the slotted hole of the expansion bearing at 70 °F (20 °C).

3. Handling Members.

All members shall be carefully handled to prevent damage to them and in a manner that any camber put into them will not be changed. One pick-up point will be permitted on pieces 50 feet {15 m} or less in length. Two pick-up points, located at or between the 1/4 and 1/3 points, will be required on pieces over 50 feet {15 m} in length. Calculations showing that the pieces will not be damaged, along with erection plans, will be required when pick-up points are requested to be located outside of these areas. This data shall be submitted in accordance with Subarticle 105.02(d). Reference is made to Article 836.17.

4. Erection Assembly.

The parts shall be accurately assembled as shown on the plans and any match marks shall be strictly followed. Splices and field connections shall have at least 50% of the holes filled using bolts (either erection or untorqued permanent bolts) and an adequate number (Minimum 10%) of forged barrel or drift type erection pins for fit up and alignment. The diameter of the erection pins shall be 1/32 inch {1 mm} larger than the diameter of the bolts. Splices and connections carrying traffic during erection shall have 75% of the holes so filled. Erection bolts shall be tightened to snug tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a person using an ordinary spud wrench. Before beginning high strength bolting, the structure shall be adjusted to correct grade and alignment.

Bolts and nuts for bolted beam and girder splices shall be placed so that (1) flange splices have nuts on the exterior face of the splice, (2) web splices have bolt heads on the outside face of exterior beams or girders.

Filler plates for bolted beam and girder splices have been based on theoretical dimensions, the thickness of the plates shall be adjusted in the shop to take care of any difference greater than 1/16 inch {1.6 mm} between the theoretical and actual dimensions. Splices in members of the same theoretical size will require filler plates if the actual dimensions vary more than 1/16 inch {1.6 mm}.

5. Defective or Damaged Material.

Any material that is damaged, distorted or in any way defective and is considered to be repairable shall be corrected by means approved by the Central Office. The Contractor shall submit a detailed proposed procedure for approval prior to making any corrections. Minor misfits involving occasional reaming of a hole will not require Central Office approval. Wholesale reaming of holes will require Central Office approval.

6. High Strength Bolting.

a. General.

High tensile strength heavy hex bolts shall be used for all field fasteners unless otherwise noted on the plans or in the proposal. The bolts, nuts, washers and direct tension indicators shall conform to the requirements of Article 836.33. All requirements for testing of materials and for calibration of equipment shall be met prior to installation.

b. Bolted Parts.

Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to the washers, shall be free of scale. They shall be free of dirt, loose scale, burrs, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing unless noted otherwise on the plans or in the proposal.

c. Bolt Assemblies.

The Contractor shall take special care in storing the bolt assemblies (bolts, nuts, washers and direct tension indicators) to prevent them from rusting. Any components of the bolt assemblies that are rusted shall be thoroughly cleaned or replaced prior to installation. Bolts that have been cleaned shall be lubricated in the field prior to installation. Plain (ungalvanized) bolts shall be "oily" to the touch when installed.

Galvanized nuts shall be lubricated with a lubricant (Beeswax or equivalent) containing a visible dye so that a visual check can be made for proper lubrication prior to installation. Special care shall be taken in storing galvanized bolts with water soluble lubricants.

d. Installation.

Galvanized nuts shall be checked to verify that a visible lubricant is on the threads.

High strength fasteners, plain and galvanized, shall be subjected to jobsite rotational-capacity tests performed in accordance with Item 836.33(c)4. prior to the start of any bolt installation. Washers are required as part of the test. A Skidmore-Wilhelm Gage or equivalent, a standard torque wrench, a suitable steel joint (to conduct test on short bolts if needed) and any other miscellaneous tools or materials required for this test shall be provided by the Contractor. This test shall be performed by the Contractor and witnessed by the Engineer.

Prior to beginning the tensioning operation each day, a minimum of one rotational-capacity test shall be performed to verify that the bolt assemblies are still properly lubricated. The bolt assembly to be tested will be determined by the Engineer and may come from any that are in question, including erection bolts which have been placed, but not tensioned. If this test fails, any assemblies which have been subjected to similar conditions as the failing sample shall be either cleaned and lubricated or replaced prior to tensioning. Additional rotational-capacity tests may be required at the discretion of the Engineer.

Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. If the markings on the nuts are raised then the nuts shall be installed with the markings to the outside. A flat washer may be used when the abutting surface adjacent to the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for lack of parallelism.

Before tightening the bolts to the required minimum tension, all bolts shall first be tightened to snug tight condition, progressing from the most rigid part of the joint towards the free edges. See Item 508.03(d)4. for a definition of snug tight condition. At snug tight, all joining pieces shall be in firm contact. All bolts shall then be tightened to give the minimum tension values shown in Table 1. Tightening shall be done by either the Calibrated Wrench Method, Turn-Of-Nut Method or Direct Tension Indicator Method. The element not being turned (bolt or nut) shall be held with a wrench during tightening to prevent rotation of the fixed element.

TABLE 1	
NOMINAL BOLT DIAMETER & THREAD PITCH	REQUIRED MINIMUM BOLT TENSION
ASTM A 325 high strength bolts only.	
1/2 inch	12,050 pounds
5/8 inch	19,200 pounds
3/4 inch	28,400 pounds
7/8 inch	39,250 pounds
1 inch	51,500 pounds
1 – 1/8 inches	56,450 pounds
1 - 1/4 inches	71,700 pounds
1 - 3/8 inches	85,450 pounds
1 - 1/2 inches	104,000 pounds
ASTM A 325M high strength bolts only.	
M16 x 2	91.0 kN
M20 x 2.5	142.1 kN
M22 x 2.5	175.7 kN
M24 x 3	205.1 kN
M27 x 3	266.7 kN
M30 x 3.5	327.2 kN
M36 x 4	474.6 kN

e. Calibrated Wrench Method.

The Contractor shall furnish all wrenches necessary to install the high strength bolts. He shall also furnish a calibration device (Skidmore-Wilhelm Calibrator or equivalent) and use it to calibrate the wrenches used for bolt installation and inspection. The calibration device shall be calibrated by the State Testing Laboratory or other approved laboratory prior to being used. The calibration results will be valid for a period of six (6) months after the date of calibration under normal conditions. The Engineer may require that the calibration device be recalibrated at any time.

Wrenches shall be calibrated on the project at least once daily and for each lot of nuts and bolts to be used. Calibration shall be accomplished by the tightening in the calibration device of not less than 3 typical bolts of each lot to be installed. Power wrenches shall be adjusted to stall or cutout at a tension slightly greater than the minimum required. If manual torque wrenches are used, the torque indication corresponding to the calibration tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount. Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately 10 seconds.

The Contractor shall spot check the completed bolt assembly installations at the direction and under the supervision of the Engineer. The spot checking shall be done to insure that the minimum bolt tension has been achieved in all of the bolts in the completed connection. The spot checks shall be made with a manual torque wrench that has been furnished by the Contractor and calibrated as noted herein to measure the minimum required bolt tension.

f. Turn-Of-Nut Method.

All bolts shall first be brought to snug tight condition as described in Item 508.03(d)4. The element being turned (bolt or nut) shall then be turned an additional fraction of a turn as specified in Table 2. Where the exterior faces of the members to be joined are sloped from normal to the bolt axis up to a 1:20 slope and beveled washers are not specified, a minimum 3/4 turn from snug tight is required for all bolts.

The Contractor shall furnish a calibration device (Skidmore-Wilhelm Calibrator or equivalent) and manual torque wrench. This equipment shall be calibrated and used to spot check the completed bolt assemblies as required under the Calibrated Wrench Method.

TABLE 2			
NUT ROTATION FROM THE SNUG-TIGHT CONDITION [a, b] GEOMETRY OF OUTER FACES OF BOLTED PARTS			
Bolt length measured from underside of head to end of bolt.	Both faces normal to bolt axis.	One face normal to bolt axis and other face sloped not more than 1:20. Beveled washer not used.	Both faces sloped not more than 1:20 from normal to bolt axis. Beveled washers not used.
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters [c]	2/3 turn	5/6 turn	1 turn

[a] Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

[b] Applicable only to connections in which all material within grip of the bolt is steel.

[c] No research work has been performed by the Research Council Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

g. Direct Tension Indicator Method.

The Contractor shall furnish direct tension indicator washers (also called load indicator washers) to be installed as a part of the final bolt assembly. He shall also furnish the gap measuring devices (feeler gages) to be used for inspection purposes. The direct tension indicator washers, noted herein as DTI washers, shall be installed by one of the following methods, however, they shall not in any case be installed in a position where the extrusions or cleats are in contact with the pieces being joined:

Plain Finished Bolts:

The nut is the turned element, the hardened washers are placed adjacent to the nuts, and the extrusions or cleats on the DTI washers are placed in contact with the bolt heads.

The nut is the turned element, the hardened washers are placed adjacent to the nuts, and the extrusions or cleats on the DTI washers are placed in contact with the hardened washers.

The bolt head is the turned element, the hardened washers are placed adjacent to the bolt heads, and the extrusions or cleats on the DTI washers are placed in contact with the hardened washers.

Galvanized Bolts:

The nut is the turned element, the hardened washers are placed adjacent to the nuts, and the extrusions or cleats on the DTI washers are placed in contact with the bolt heads.

All bolts shall first be brought to snug tight condition as described in Item 508.03(d)4. The bolts shall then be tightened to compress the extrusions on the DTI washers. The DTI washers shall be compressed to the point that the gap between the DTI washer (on the extrusion side of the washer) and the adjacent element is reduced to that shown in Table 3. The maximum allowable gap (minimum allowable bolt tension) is the condition where the feeler gage can be entered to the shank of the bolt in only one half of the number of places where inserted around the circumference of the washer. The minimum allowable gap is the condition where the feeler gage cannot be entered in one half or more of the applied places and the gap is not completely closed.

The Contractor shall furnish a calibration device (Skidmore-Wilhelm Calibrator or equivalent) to be used at the job site to determine the acceptability of the DTI washers. This calibration device shall be calibrated as noted under the Calibrated Wrench Method. Three bolt assemblies of each diameter, length and grade shall be checked at the job site in the calibration device. These bolt assemblies shall be installed in the calibration device in the same manner as the intended installation in the structure and shall be tightened with the same equipment intended for job use. A calibration test shall be conducted by tensioning a bolt assembly to the point that the maximum allowable gap is present between the DTI washer and the adjacent element. At this point the tension reading taken from the calibration device shall not be less than five percent greater than the tension required.

The Engineer will use the feeler gages to spot check the completed bolt assembly installations.

The Contractor shall furnish a manual torque wrench which shall be calibrated and used to spot check the completed bolt assemblies as required under the Calibrated Wrench and Turn-Of-Nut Methods.

TABLE 3	
DIRECT TENSION INDICATOR METHOD	
Uncoated Bolts w/DTI Under Turned Element	Maximum Allowable Gap = 0.005 in. {0.127 mm} Minimum Allowable Gap *
Uncoated Bolts w/DTI Under Unturned Element	Maximum Allowable Gap = 0.015 in. {0.381 mm} Minimum Allowable Gap *
Galvanized Bolts w/DTI Under Unturned Element	Maximum Allowable Gap = 0.005 in. {0.127 mm} Minimum Allowable Gap *
* See fourth paragraph of this Subitem (508.03(d)6.g.) above	

h. Correction of Deficiencies.

All deficiencies found during calibration, installation and spot checking of the bolt assemblies shall be corrected by the Contractor.

i. Cleaning.

All exposed surfaces of bolt assemblies shall be cleaned prior to painting with a cleaning solvent such as mineral spirits or turpentine. This cleaning shall not damage the existing primer coats of paint.

7. Bolted Connections.

The bolt length used shall be such that the end of the bolt is flush with but does not extend more than ¼" beyond the outer face of the nut when properly installed. In bolted connections, other than high strength steel bolts, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

8. Welded Shear Connector Studs.

In compliance with OHSA safety requirements structural steel bridges which would require welded shear connector studs shall have the studs installed on all steel girder top flanges at the project site after formwork has been totally installed between all completely set and erected girder lines, thus minimizing fall hazards for workers. The required locations of the studs shall be marked at the bridge fabrication shop. The fabricator shall center punch the steel at the center of all stud locations to provide a durable marking. A highly visible indelible paint marker shall also be applied over the center punch points prior to shipment of girders to the project.

The Contractor shall notify the Project Manager of the date that installation of the studs will begin in the field. This notification shall be given a minimum of five calendar days prior to the date of installation. The Project Manager will notify the Bridge Engineer of the installation date so that the inspection of the installation can be made by a representative of the Bridge Engineer. Studs shall not be installed until the representative of the Bridge Engineer is given the opportunity to inspect the preparation of base metal, layout and the location of the studs including the studs and ceramic ferrules to be used in the operations. The fusion areas on the top flange to which studs are to be welded shall be cleaned to bright metal before welding. The fusion area of the studs should be clean and free of rust. Once the stud welding operations are underway one stud out of every tenth row of studs on each girder line will require bend testing to 30° from its original axis for assurance that the studs are being applied properly. Any

stud that exhibits a failure will be replaced with a new stud after the base metal location of the failed stud is repaired by grinding to bright and sound metal.

Studs shall be one of those shown in List II-4 of the ALDOT manual "MATERIALS, SOURCES, AND OTHER DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS".

Studs shall be attached in accordance with the requirements given in the AASHTO/AWS D1.5M/D1.5:2015, Bridge Welding Code, Seventh Edition.

9. Painting.

Painting shall conform to requirements of Section 521.

10. Name Plates.

No permanent plates or markers other than those shown on the plans or approved will be permitted on any structure. Any marks or signs painted on structural steel by the fabricator or contractor shall be obliterated prior to applying the first field coat by cleaning and/or painting over the marks or signs with paint of the same type used for the shop coat.

(e) Field Inspection.

All work shall be subject to the inspection of the Engineer who shall be given all facilities required for all necessary inspection. Material and workmanship not previously inspected will be inspected after its delivery to the site of the work. Whether shop inspection is made or not, workmanship and materials which do not conform to the Specifications may be rejected at any time prior to acceptance of the project.

(f) Cleaning up of Worksite.

Upon completion and before final acceptance, the Contractor shall remove all falsework and other temporary construction, and shall leave the site in a condition acceptable to the Engineer.

508.04 Method of Measurement.

(a) Items No. 508-A, and 508-D.

The theoretical poundage {mass} of accepted metal in the per pound {kilogram} price items, complete in place, will be computed in conformity with the following:

1. The weight {mass} of steel shall be assumed at 0.2833 pounds per cubic inch {7850 kg/m^3}. The weight {mass} of cast iron shall be assumed at 0.26 pounds per cubic inch {7200 kg/m^3}. The weight {mass} of bronze shall be assumed at 0.315 pounds per cubic inch {8150 kg/m^3}.
2. The weights {masses} of rolled shapes in the completed structure, shall be calculated on the basis of their theoretical weights {masses} and dimensions given in the handbooks of the mills rolling the various sections and shapes. The weights {masses} of steel plates shall be computed on the basis of their detailed dimensions as shown on the approved shop drawings. Weights shown on the approved shop drawings shall not be used for payment purposes.
3. The weight {mass} of castings shall be calculated from the detail dimensions shown on the approved shop drawings, with an addition of 10 percent for fillets, overrun and finishing.
4. Only the weight {mass} of materials used in the completed, permanent work will be measured for payment.
5. No allowance in weight {mass} will be made for shop or field paint.
6. For the purpose of measurement and payment, incidentals such as bearing plates, pedestals, and other minor metal parts shall, unless otherwise provided, be considered as structural steel even though made of other materials except the bronze bearing plates and the PTFE coated bearing plates will be paid for under Item 508-C.
7. For purposes of measurement and payment when payment is on a per pound {kilogram} basis, required welded shear connection studs will be included in the quantity of structural steel.

(b) Item No. 508-B.

1. The number of units measured will be the accepted number of structural span units complete in place.

2. Any estimated weights {masses} shown on the bidding plans or proposal are approximate only and the contract price for each item shall include full compensation for the specified structural unit, complete in accordance with the plans and specifications, regardless of the final weight {mass} required and no claim will be allowed for any increase over the estimated weight {mass} of a structural unit unless same is caused by a change in plans or specifications. The cost of any additional work caused by a change in plans or specifications will be paid for as Extra Work.

(c) Item No. 508-C.

Unless otherwise specified on the plans, the Contractor will have the option of furnishing either self-lubricating bronze bearing plates or PTFE coated bearing plates.

The bearing plates furnished will be measured in sets complete in place. A set shall include all the bearing plates required for each structure. Steel plates used in the bronze plate assembly or any other steel plates used in the PTFE plate assembly will be measured as Item 508-A, 508-B or 508-D, whichever is applicable.

(d) Item No. 508-E.

Inspection ladders, when specified for separate payment, shall consist of all ladders required in accordance with plan details for the locations designated measured as one unit. When no separate payment is designated, the cost of such shall be included in the unit price bid for the Item of Structural Steel provided in the contract.

(e) Item No. 508-F.

When separate payment is designated for a bridge deck drainage system, the complete system required to drain each separate structure in accordance with plan details will be measured as one unit per bridge structure. When no separate payment is designated for a bridge deck drainage system, the cost of such will be considered incidental to the work and absorbed in the unit prices bid for other items of work.

508.05 Basis of Payment.

(a) Items No. 508-A and 508-D.

The accepted theoretical poundage {mass} of metal in the per pound {kilogram} price items, computed as prescribed, will be paid for at the contract unit price bid for structural steel complete in place, which will be payment in full for fabricating, furnishing, transporting, erecting, and painting (field painting not included in Item No. 508-D) all material, and for all labor, equipment, tools, falsework, cleaning up and incidentals necessary to complete the work.

Unless noted otherwise on the plans, these items shall include the following:

- bridge joint armor plates (both sides of the joint)
- pile cap channels and plates
- connection angles (clip angles) used with prestressed concrete girders
- swedged anchor bolts, nuts and washers
- smooth and swedged dowels
- pipe sleeves

(b) Item No. 508-B.

Accepted metal superstructure span units will be paid for at the contract unit price bid for each respective unit, complete in place, which shall be payment in full for furnishing, fabricating, transporting, erecting and painting all materials and for all labor, equipment, tools, falsework, cleaning up and incidentals necessary to complete the work.

Unless noted otherwise on the plans, this item shall include the following:

- All structural steel in the superstructure unit
- Structural steel in the bearing devices, except the PTFE coated bearing plates
- Expansion dams (finger joints , etc.) for interior and exterior open bridge joints

Where separate pay items are not provided, this item shall also include furnishing, fabrication, painting or galvanization, transporting and installing ladders, platforms, catwalks, and navigational lighting brackets.

Joint armor plates, channels, angles, anchor bolts, etc. for sealed interior and exterior bridge joint design shall be as specified in Section 522 and are not as a part of this item. This item does not include reinforcing steel and concrete.

Structural steel bearing plates for Type 3, 4 and 5 elastomeric bearings shall be included in the payment for elastomeric bearings under Pay Item 511-A and are not a part of this item.

(c) Item No. 508-C.

Payment for bearing plates furnished, complete and installed as shown on the plans, will be made at the contract unit price per set which shall be compensation in full for furnishing and installation and for all tools, labor and incidentals necessary to complete the item.

(d) Item No. 508-E.

Accepted ladders, measured as noted above, will be paid for at the contract lump sum price bid for this item. Said lump sum price bid shall be full compensation for all ladders designated complete in place and including all cost for furnishing, fabricating, painting, galvanizing, erection and installing the ladders, and for all materials, tools, equipment, labor and incidentals necessary to complete the work.

(e) Item No. 508-F.

Accepted bridge deck drain systems, measured as noted above, will be paid for at the contract lump sum price bid for each system, complete in place. Said lump sum price bid shall be payment in full for furnishing and installing of all materials, fabrication of materials, erection of materials, paint (if required) and for all tools, equipment, labor and incidentals necessary to complete the work.

(f) Partial Payment.

1. Partial Payment for Steel Plates and Shapes prior to Fabrication.

Partial payment may be made for steel plates and shapes prior to fabrication. The requirements given in Article 109.07 shall be applicable to these partial payments except as amended or supplemented by the following:

- a written request for partial payment shall be submitted by the Contractor that shall include the number of pounds {kilograms} of steel for which payment is requested and the dollar amounts and percentages of partial payment for each contract pay item affected by the request;
- the request for partial payment shall include the dimensions, heat numbers, purchase order numbers, and inventory markings for all plates and shapes;
- only one request per fabricator for partial payment for steel plates and shapes for fabrication will be considered prior to fabrication;
- the written request must be approved by the Construction Engineer and Bridge Engineer before further consideration will be given to making partial payment;
- all of the plates and shapes required for fabrication on the project shall be available for inventory prior to the beginning of fabrication and shall be clearly marked with an inventory identification;
- plates and shapes shall be stored in a manner that will allow the easy identification of each plate and shape;
- the Contractor shall make arrangements with the Engineer for the inventory to be made by the ALDOT Bridge Bureau's Structural Steel Inspection personnel;

2. Partial Payment after Fabrication.

Partial payment will be allowed after the completion of fabrication in accordance with the requirements given in Article 109.07.

3. Partial Payment after Installation.

After the structural steel is installed, all connections are complete, all splice plates and bolts have been cleaned and painted, and the entire shop coating has been acceptably applied and cured, 95 % of the payment may be made for the structural steel.

4. Final Payment.

After the completion of installation, the acceptable application and curing of the field coating, and the cleaning of the superstructure, 100 % of the payment may be made.

If weathering steel is installed and painting is not required, 100 % of the payment may be made after the superstructure concrete is placed and the superstructure has been cleaned.

(g) Payment will be made under Item No.:

508-A Structural Steel - per pound {kilogram}
508-B Structural Steel Superstructure, ___*___, ___**___, ___***___ (SPECIALTY ITEM) - per each
508-C Bearing Plates ____**** - per set
508-D Structural Steel (Except Field Painting) - per pound {kilogram}
508-E Furnishing, Fabrication & Installation of Ladders - per lump sum
508-F Bridge Deck Drainage System - per lump sum

* Length of Continuous/Simple Span

** Lane, if applicable

*** Approximate weight {mass} of structural steel

**** If a specific type of bearing plate is required, so designate (Bronze or PTFE) Example: 508-B Structural Steel Superstructure, 100'-100'-100' Continuous Span, Left Lane, Approx. 373,100 pounds (SPECIALTY ITEM)

SECTION 509
TIMBER

509.01 Description.

This Section shall cover the work of furnishing, preparing, and erection of timber or lumber of the stress values, grade, size, and dimensions designated by the plans or proposal. The timber may be treated or untreated as specified by the plans and may require painting if so specified. It shall also include all structural steel, iron, casting, other metal parts, and all hardware required by the Specifications and plans. The type of preservative used shall be the type called for in the plans and/or proposal form. Where more than one type of preservative is included in the contract, each type shall be used as indicated by the plans.

509.02 Materials.

All materials shall conform to the appropriate provisions of Division 800, Materials. Specific reference is made to Section 833, Lumber and Timber, Untreated and Treated

509.03 Construction Requirements.

(a) Handling and Storage.

Timber and lumber shall be carefully handled without dropping, breaking of outer fibers, bruising, or penetrating the outer surface with tools. Tongs, cant hooks, peavys, hooks, pike poles, or other equipment likely to break the surface shall not be used.

(b) Workmanship.

Only competent carpenters shall be employed and all framing shall be true and exact. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for the removal of workmen causing them. Any metal work required in conjunction with timber construction shall conform to the requirements of Section 508.

(c) Holes for Bolts, Dowels, Rods, and Lag Screws.

Holes for round drift bolts and dowels shall be bored with a bit 1/16 inch {1.6 mm} less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel. Holes for machine bolts shall be bored with a bit of the same diameter as the bolt. Holes for rods shall be bored with a bit 1/16 inch {1.6 mm} greater in diameter than the rod. Holes for lag screws shall be bored with a bit 1/16 inch {1.6 mm} less in diameter than the nominal diameter and for a depth not greater than 1/2 the length of the lag screws being used. Countersinking shall be done wherever smooth faces are required. Recesses formed for countersinking shall be painted with hot creosote oil, and after the bolt or screw is in place, shall be filled with an asphalt base roofing patch.

(d) Bolts and Washers for Timber Construction.

One washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood. Cast iron washers shall have a thickness equal to the diameter of the bolt, and a diameter of four times the thickness. For malleable or plate washers, the diameter or side size of the square shall be equal to four times the diameter of the bolt, and the thickness of the washers shall be equal to one-half the diameter of the bolt. Cast iron washers shall be used when the timber is in contact with the earth . All bolts shall be checked after the nuts have been finally tightened. Bolts shall be of such length that not more than 1 inch {25 mm} will protrude beyond the nut when finally tightened.

(e) Additional Details.

Additional requirements for timber construction will be listed under the type work for which the timber is used, including but not limited to Sections 503, 505, 510, 630, 631, 635, 636, and 637.

509.04 Method of Measurement.

The quantity to be measured shall be the number of thousand feet board measure {cubic meters} of lumber and timber, complete in place and accepted. Measurements of lumber and timber will be computed using the nominal width and thickness, and the actual length of each piece shown on the plans, unless changes in such dimensions have been authorized in writing. The nominal size dimensions shall be used in the computations even though the actual size be scant in the amount provided above. The measurements of timber will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, bracing, sheeting, etc.

509.05 Basis of Payment.

(a) Unit Price Coverage.

1. Accepted timber and lumber will be paid for at the respective contract unit prices bid per thousand feet board measure {cubic meter}, for untreated timber, treated timber of the designated type, preservative, complete in place, which shall be payment in full for furnishing of all materials, preservative treatment, equipment, tools, labor, hardware (as provided by Article 836.11), and incidentals necessary for the erection and painting (where provided by the plans and/or proposal form) of the work as shown on the plans or specified. It shall include compensation for any excavation and backfill necessary to complete the timber portion of the structure within the limits of the abutments or end bent, and when provided by the plans and/or proposal forms; it shall further include compensation for removal of any untreated or treated timber replaced by new material as directed.

2. Accepted treated timber, (any preservative) (salvaged material) will be paid for at the contract unit price bid, complete in place, which shall cover the cost of furnishing equipment, tools, hardware, incidentals, materials, hauling, handling, and placing of materials salvaged from old structures (or furnished by the State). It shall also cover the cost of removal of any material replaced by salvaged material as provided by the plans.

(b) Metal Parts and Piling.

Metal parts, other than hardware (as provided by Article 836.11), will be paid for at the contract prices per linear foot {meter} or per pound {kilogram} for such items, the weight {mass} being computed in the manner as specified for structural steel. Piling will be paid for as specified under Piling.

(c) Payment will be made under Item No.:

509-A Untreated Timber - per MBM {cubic meter}
509-B Treated Timber, Type Preservative - per MBM {cubic meter}
509-C Treated Timber (Any Preservative)(Salvaged Material) - per MBM {cubic meter}

SECTION 510
BRIDGES

510.01 Description.

The work under this Section shall cover the construction of bridges, or parts thereof, including members designated as mass concrete. When widening or modification of an existing facility is required, the work under this Section shall include the cutting or breaking away of portions of the existing structural material and the preparation of the exposed structural materials for joining of new materials to the lines and grades shown on the plans or as directed.

The requirements for concrete temperature monitoring, maximum allowable concrete temperatures, and the Thermal Control Plan (ThCP) are covered in this section. The requirements of this Section shall apply to any concrete element that is designated as mass concrete in the Contract Documents. A ThCP to control and monitor concrete temperatures is required for all mass concrete elements.

510.02 Materials.

(a) General.

All materials incorporated in the structure shall be new except where otherwise specified on the plans or in the proposal. The requirements set forth in the Sections listed in this Article, together with any other specifications contributing to the complete structure shall be applicable to this Section.

Section 215	Excavation for Bridges
Section 501	Structure Concrete
Section 502	Steel Reinforcement
Section 505	Piling
Section 508	Structural Steel and Miscellaneous Metals
Section 509	Treated and Untreated Timber
Section 513	Prestressed Concrete Bridge Members
Section 521	Bridge Painting

All requirements provided for Structural Portland Cement Concrete, Section 501, shall apply to mass concrete members, except where otherwise indicated by specific requirements given in this Section or noted by plan details.

All steel reinforcement used in a cast-in-place concrete bridge deck shall be AASHTO M 31 {M 31M} Grade 60 {Grade 420}, unless otherwise specified on the plans.

(b) Material Requirements for Mass Concrete.

Type III portland cement (high early strength cement) shall not be used in mass concrete.

The maximum substitution of portland cement with mineral admixtures shall not exceed 75 percent. The maximum substitution of portland cement with any one mineral admixture substitution is defined in the following table:

MAXIMUM PERCENT MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT (substitution by weight)	
MINERAL ADMIXTURE	MAXIMUM PERCENTAGE SUBSTITUTION
Class C or Class F Fly Ash	40 %
Ground Granulated Blast Furnace Slag	75 %
Microsilica	10 %

510.03 Construction Requirements.

(a) General.

1. Bridges shall be constructed in accordance with lines, grades, dimensions, and other details shown on the plans and in conformity with these specifications.

2. Construction requirements of Sections 215, 501, 502, 503, 505, 507, 508, 509, 512, 513, 517, 520, and 521 shall also apply to this Section.

3. Concrete tolerances except for bridge deck riding surfaces shall be as follows:

- Width and depth dimensions of girders, barrier rails, and columns shall not vary more than 1/8 inch per foot {10 mm/m} and not more than 1/4 inch {6 mm} total from plan dimensions.
- For barrier rail, overhang, and curb, horizontal and vertical alignment shall not vary more than 1/8 inch in 10 feet {3 mm/3 m} and not more than 1/4 inch {6 mm} total from that shown on the plans.
- The finished concrete shall be free from objectionable projections, swells, ridges, depressions, waves, holes, and other defects.

4. The requirements for curing and finishing the concrete are given in Section 501.

5. Attention is directed to the requirements of Article 107.01 concerning safety.

(b) Substructures.

1. Foundations.

Foundations shall be prepared in accordance with the plans and Section 503.

2. Concrete and Steel Substructures.
See construction requirements of Sections 501, 502, and 508.

3. Piling.
See Section 505.

4. Drilled Shafts.
See Section 506.

(c) Superstructures.

1. General.
No superstructure load shall be placed upon finished piers or abutments until directed. Moreover, before any superstructure load is placed on concrete portions of a substructure, one of the following shall be accomplished: (1) A minimum time of 14 days, exclusive of days where four hours or more the temperature is below 40 °F {5 °C}, shall be allowed for the hardening of concrete, or (2) the concrete shall indicate a development of minimum compressive strength of 2800 psi {19 MPa} from cylinders prepared in conformity with AASHTO T 23.

2. Bearings and Anchorage.
See Item 508.03(d)2.

3. Steel Girders.
See Section 508.

4. Prestressed Concrete Bridge Members.
See Section 513.

5. Cast-in-Place Concrete Girders,
See Sections 501 and 502. Camber due to dead load and vertical curvature shall be put into the falsework and formwork as required to produce the finished lines and grades shown on the plans.

6. Reinforced Concrete Bridge Decks.

a. Pre-Pour Conferences.
Pre-pour conferences shall be held between the Contractor and Project Manager prior to placing any bridge deck concrete. As a minimum, this conference shall include a discussion of the rate of pour, personnel and equipment to be used, type of finish, and curing details.

b. Placing Concrete.
In addition to the requirements given in Section 501, the following shall also apply. The rate of pour shall be controlled so that all concrete between construction joints can be placed and compacted in a continuous operation before initial set takes place in contiguous portions of the concrete. In case of breakdown of equipment or other reasons necessitating suspension of placing and compacting the concrete for a period in excess of 45 minutes for mixes without retarders or 60 minutes for retarded concrete, and part of the work involved is such that a construction joint will not be permitted, all of the previously placed concrete in that section shall be removed and replaced by the Contractor without extra compensation.

A deck pour shall not be started when it is raining or threatening rain. Should inclement weather develop during the pour, it will be the Contractor's responsibility to protect the plastic concrete so that placing and finishing operations can be satisfactorily completed without damage to the concrete or concrete surface. Should damage occur, the concrete shall be removed and replaced at the Contractor's expense. The placing of skin patches (the scabbing on of the concrete or grout) on a bridge deck will not be permitted.

All concrete deck slabs shall be placed full thickness in one operation. Unless otherwise shown on the plans, on R.C.D.G. spans, concrete in the girders and slab shall be placed in one operation.

Webwalls may be poured and allowed to set up prior to pouring the bridge deck. If a longitudinal screed is to be used for finishing the concrete in the bridge deck, the concrete for the bridge deck shall not be placed until the webwall concrete has reached a minimum compressive strength of 2800 psi {19 MPa} as determined from the testing of cylinders.

On all continuous spans, a pouring sequence will be shown on the plans. All lower numbered or lettered pours shall be made prior to proceeding to the next higher numbered or lettered pour. Adjacent pours shall not be made until after the previously placed concrete has reached an age of 24 hours.

Simple spans shall be constructed in one pour, except on simple spans over 50 feet {15 m} in length transverse slab construction joints will be permitted. On simple spans over 80 feet {25 m},

transverse slab construction joints will be required. Where slab construction joints are used on simple composite spans, construction joints shall be placed at approximately the quarter points of the span; after pouring the center portion of the span and when the concrete has reached a compressive strength of 2800 psi {19 MPa} by cylinder tests, or after four days, the end slab portions of the span may be poured.

Consideration will be given to reducing the number of construction joints specified above where transverse screeding is to be employed; however, all requests for changes to pouring sequences must be submitted in writing to the Construction Engineer for approval. If the number of construction joints is reduced, a minimum pour rate of 30 cubic yards {23 m^3} per hour may be required, and an approved retarder may be required in the deck concrete.

During the placing operation, the concrete shall be placed in strips just ahead of the screed for the entire length or width of the pour, whichever applicable. A small roll of grout shall be kept on the leading edge of the screed so that all depressions ahead of the screed will be filled.

c. Finishing.

(1) General Screed Requirements.

All screeds shall be mechanically operated. Screeds and screed supports shall be designed so that they may be pre-set to provide the finish grade and cross-section of the concrete deck surface shown on the plans. They shall be of substantial construction so that the proper settings will be maintained throughout the pour. Screed supports shall be placed and adjusted to properly provide for the deflection of forms, falsework, and structural supporting members which will occur during the placement of concrete. Immediately before concreting operations are started, the screed shall be operated over the full length and width of the bridge segment to be paved. This test run shall be made with the screed adjusted to its finishing position. While operating the screed during this test, all aspects of the screed and supports shall be checked for proper adjustments. After the Contractor has satisfied himself that the finishing equipment has been adjusted to conform with plan and specification requirements, another test run shall be made for the Engineer for the purpose of recording slab thickness and steel clearance measurements prior to the pour being made.

(2) Longitudinal Screeds.

Longitudinal screeds shall be supported at the ends by transverse headers or by a section of slab previously poured. Screeds must be long enough to span the entire pour as required by the plans and specifications. Intermediate screed supports between approved construction joints will not be permitted. Screeding shall be accomplished by working the longitudinal screed parallel to the centerline of the road (from low side to high side on superelevated curves) in such a manner that laitance, surplus water, and inert materials are removed from the surface.

(3) Transverse Screeds.

Transverse screeds shall be of sufficient weight {mass} to strike off the plastic concrete placed in front of the screed without "riding up" on the concrete. Transverse screeds shall be supported by vertically adjustable rails set a sufficient distance from the gutter line to allow free movement of the screed from gutter line to gutter line. Supports for the screed rail shall be located a maximum of 18 inches {450 mm}, center-to-center, with the slab overhang support brackets located a maximum of 24 inches {600 mm}, center-to-center. Exceptions to the maximum allowable screed rail and support bracket spacing will be considered if the increased spacing is adequately addressed in the design calculations that are required as a part of the Working Drawings (for falsework). Satisfactory means of load distribution with minimum rail deflection shall be provided. The screed rails for any deck pour shall be completely in place for the full length of the pour and shall be firmly secured prior to making test runs and subsequently placing deck concrete. In making the test runs, a "tell-tale" device attached to the screed carriage may be used to check the proper clearance on the top mat of the reinforcing steel.

(4) Work Bridges.

Portable work bridges shall be provided and used to perform finishing and inspection work on the bridge deck after the screeding operation. Surface tolerance as described in Subitem 510.03(c)6.d shall be accomplished before grooving the deck surface.

(5) Final Finishing.

The final finish behind longitudinal screeds shall be obtained by wood floating or by broom finish. The final finish behind transverse screeds shall be obtained by either wood floating, broom

finish or burlap drag. Brooms for broom finishing shall have medium to stiff nylon bristles. The final texture shall be obtained by the cutting of transverse grooves in the cured concrete.

The bridge decks shall be grooved perpendicular to the centerline. The grooving operation shall not be started until the bridge deck has been cured in accordance with the requirements given in Section 501.

The grooves shall be cut into the hardened concrete using a mechanical saw device which will leave grooves approximately 1/8 inches {3 mm} wide and 1/8 inches {3 mm} deep. The grooves shall be unevenly spaced and randomly varying between 5/8 inches {15 mm} and 1.125 inches {30 mm}. The grooved finish shall be at right angles to the centerline of the bridge deck, regardless of skew, and shall extend across the roadway from 2 feet {600 mm} inside the face of the curb or barrier rail to 2 feet {600 mm} inside the face of the opposite curb or barrier rail. Each pass of the grooving machine shall be adjacent to the previous pass without overlapping.

All residue, slurry and other waste resulting from the grooving operation shall be continuously removed from the bridge deck so that there is never a build-up of these waste materials. Upon approval by the Engineer, these waste materials may be disposed in earthwork when earthwork is a part of the bridge construction project. The waste materials may be tilled into the earthwork so that water run-off will not transport these materials from the construction site. If the Engineer does not approve of the disposal of the waste material on the construction site, the Contractor shall remove the waste material from the project and dispose of it in accordance with all applicable laws and ordinances for disposal.

d. Surface Tolerance.

The floor shall be constructed to correct elevation, including vertical curvature, within a tolerance of 1/8 inch {3 mm}, except that camber in spans 100 feet {30 m} and longer may exceed the designated amount by 1/4 inch {6 mm} at the midpoint of span. A slight excess of camber is preferred. As soon as the surface has set sufficiently, it shall be straight-edged by the Contractor under the direction of the Engineer and all areas exceeding 1/8 inch in 10 feet {3 mm in 3 m} from the longitudinal and transverse lines shown on the plans shall be marked and corrected by approved methods. The 10 foot {3 m} straight-edge shall be lapped at least 5 feet {1.5 m} over the prior 10 foot {3 m} check.

e. Curing.

The requirements for curing are given in Section 501.

f. Drainage.

Deck drains or scuppers shall be installed in the gutters at locations and in accordance with details shown on the plans.

g. Slab Overhang.

The under surface of overhanging slabs shall be provided with a continuous "V" groove 3/4 of an inch {20 mm} in depth at a point not more than 6 inches {150 mm} from the outside face for the purpose of arresting the flow of water, and thus, preventing staining,

h. Expansion Joints.

Plates, channels, or other structural shapes shall be accurately shaped, in the shop, to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of these specifications and/or the plans covering those items. Care shall be taken to insure that the surface in the finished plane is true and free from warp. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. Unless otherwise shown on the plans, the joint opening shown on the plans is the opening when the temperature of the structure is 70 °F {20 °C}. Special care shall be taken to insure that all expansion joint devices and expansion joint openings are correctly set prior to pouring the concrete adjacent to the joint.

Expansion joints shall be so constructed as to permit freedom of movement of the spans. Open joints shall be cleared of all mortar and other obstructions as soon as possible after pouring the spans.

Sealing of joints, if required, shall be in accordance with plan details.

i. Blank.

j. Barrier Rails Placed By Slip Forming.

Bridge barrier rails constructed by the use of a slip form extrusion machine shall be well compacted dense concrete meeting all the requirements of Section 501, except for the requirement

for fixed forms. The forming portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine so that the top of the barrier can be maintained at the required grade.

Open joints shall be located as required on Standard Drawing No. I-131. Longitudinal bars shall be cut at joint locations to provide for 2 inch {50 mm} end cover. The Contractor shall be responsible for marking these locations in advance of placement of concrete so that sawed joints will be properly located.

The joints shall be sawed as soon as the concrete has hardened to the degree that tearing and raveling is not excessive, and before uncontrolled shrinkage cracking begins. This time may be as short as four hours or even less in extremely warm weather, but not over 12 hours unless authorized by the Engineer. If extreme conditions exist which make it impractical to prevent uncontrolled cracking by early sawing, the procedure shall be revised immediately to adjust the sequence of sawing.

A minimum saw cut width of 5/16 of an inch {8 mm} shall be maintained. On the inside of the barrier, the saw cut shall extend from the top to the bottom of the rail to the point of intersection with the bridge deck. On the outside of the barrier, the saw cut shall extend from the top to within 11 inches {280 mm} of the bottom of the rail.

k. Placement of Cranes on Bridge Decks.

A crane shall not be placed on a bridge deck until Working Drawings for the placement and operation of the crane are distributed by the Department. Working Drawing shall be submitted in accordance with the requirements given in Section 105. The Working Drawing submittal shall include:

(1) Specifications of the crane and/or equipment to be placed on the structure.

(2) Mobilization (wheel location) diagram of the crane (with respect to centerline of structure) as it is being mobilized for final positioning on the structure.

(3) Final positioning/usage diagram once the crane is on the structure showing the location of the outriggers, and timber mat requirements (i.e. mat thickness, width, orientation of mats), maximum load to be lifted for a particular positioning of the boom, etc.

(4) A complete stress analysis (superstructure and substructure) on all components affected by loads resulting from the use of the crane and/or equipment on the structure. The analysis shall be provided in accordance with AASHTO Allowable Stress Design Method. Mobilization analysis (item 2) as well as final positioning/usage analysis (item 3) will be required. The results of the analysis shall be noted on the submittal by a written conclusion that the placement of the crane will not damage any part of the bridge .

7. Concrete Railings, Curbs, Sidewalks, and Parapets.

In no case shall concrete railings, sidewalks, and parapets be placed until the falsework for the span has been released, rendering the span self-supporting.

The surface of all bridge sidewalks shall have a wood-float finish. No other finish will be required.

8. Grounding.

If grounding is required by the plans, each exterior girder of bridges or portions of the bridges using steel girders shall be made electrically continuous by means of copper bonding jumpers across each expansion joint. Jumpers shall be extra flexible copper conductor, No. 2 AWG or larger. They shall be exothermically welded on the inside of the web close to the bottom flange. Jumpers shall be sized to permit 10 inches {250 mm} movement between girders without straining the jumper or connections. Grounding fields shall be provided at each end of such bridges or portion of bridges. Where end of bridge terminates at an abutment, the field shall consist of one or more driven ground rods as required to give a resistance to ground not to exceed 25 ohms. Multiple grounds or sectional ground rods will be acceptable. Connections between ends of bridge and ground field shall be copper conductor, No. 6. or larger, protected against mechanical injury in all exposed portions by galvanized steel conduit. Resistance measurements shall not be made within 48 hours after a rain shower, or until the ground is reasonably dry after prolonged rainy weather. Where steel sections of bridges terminate at intermediate bents, the grounding field shall consist of No. 2/0 standard stranded copper conductor welded to steel piling or steel reinforcing rods, whichever extends to the lowest depth, and a 2 foot {600 mm} or longer section of copperweld grounding rod extended 4 inches {100 mm} above the bent cap adjacent to end of steel section. All welds shall be exothermic. Connection between ground rod and structure shall be a No. 2 AWG or larger, extra flexible electric copper

conductor with provisions for not less than 12 inches {300 mm} horizontal movement of the structure at point of connection. Reference is made to Article 836.09 for additional material requirements.

(d) Mass Concrete.

1. Temperature Recording & Monitoring

In-place concrete temperatures shall be monitored and recorded for a minimum period of 7 days after concrete placement, unless otherwise designated by the Engineer.

Temperatures shall be electronically recorded automatically by a recorder furnished by the Contractor and shall be capable of continuously recording a minimum of one reading per hour for the duration of the mass concrete temperature monitoring period. The sensors and recorder shall be accurate to within ± 2 °F {1 °C} within the temperature range of 40 °F {4 °C} to 200 °F {93 °C}. The proposed temperature sensors and recorder for the project shall be defined in the ThCP for approval by the State Materials and Tests Engineer.

Sensors shall be installed in accordance with ALDOT-455.

The concrete producer shall be responsible for controlling the concrete temperature at delivery, per ALDOT-352. The Contractor shall be responsible for controlling the concrete temperature thereafter.

2. Maximum In-Place Concrete Temperature.

The maximum in-place concrete temperature limit for mass concrete shall be 160 °F [71 °C}.

The maximum in-place concrete temperature limit may be raised to 185 °F {85 °C} if the project concrete mix design contains mineral admixtures at one of the following minimum substitution rates:

Mineral Admixture	Minimum Substitution Percentage
Class F fly ash only	25%
Class C fly ash only	35%
GGBFS	35%
Microsilica (with Class F fly ash)	5% microsilica, 20% Class F fly ash
Microsilica (with GGBFS)	5% microsilica, 25% GGBFS

3. Maximum In-Place Concrete Temperature Differential.

The maximum in-place concrete temperature differential is defined as the difference in measured temperature at the core of the member and the measured temperature at the surface. The maximum in-place concrete temperature differential for mass concrete shall be 35 °F {19 °C}

Alternatively, the Contractor may, at his expense, determine the coefficient of thermal expansion (CTE) for the project concrete mix design, per AASHTO T 336, and develop an age-dependent maximum in-place concrete temperature differential, per ALDOT-456.

4. Thermal Control Plan (ThCP)

The Contractor shall submit a written ThCP to the State Materials and Tests Engineer for approval describing the procedures that will be used during the 7-day period following concrete placement, so that the maximum in-place concrete temperatures and maximum in-place concrete temperature differentials do not exceed the limits defined in Items 510.03(d)2 and 510.03(d)3. The ThCP shall be developed by a Professional Engineer, licensed in the State of Alabama, who shall be competent in the modeling, design, and temperature control of mass concrete. This Engineer shall be called the Thermal Control Plan (ThCP) Engineer.

The ThCP shall list actions to take when any of the temperature limits set in Items 510.03(d)2 and 510.03(d)3 are exceeded or anticipated to be exceeded. The ThCP shall be submitted at least 30 calendar days before the first intended mass concrete placement. The Contractor shall not place concrete covered by this specification until the ThCP has been accepted for completeness in writing by the State Materials and Tests Engineer and the equipment and materials necessary to facilitate the plan are on site and ready for use.

The ThCP shall include the following:

- Concrete mixture design per ALDOT-170. If the concrete mixture proportions are changed, then the ThCP shall be updated.
- The maximum in-place concrete temperature in accordance with Item 510.03(d)2 that shall be used for the project.

- The maximum in-place concrete temperature differential in accordance with Item 510.03(d)3 that shall be used for the project. If an age-dependent maximum concrete temperature differential is used, it shall be defined in tabular form, and the CTE shall be reported.
- Calculated or measured adiabatic temperature rise of the mass concrete element.
- Proposed methods to control concrete temperature at time of placement, such as pre-cooling of raw materials or concrete.
- Proposed methods to control maximum concrete temperature during curing. A mechanical cooling system may be used to control the internal temperature of mass concrete during curing but shall be designed in conformance with the ThCP. If a mechanical cooling system is used, the plans for the cooling system operation and final grouting after cooling shall be submitted to the State Materials and Tests Engineer for approval.
- Maximum concrete temperature at time of placement used during the development of the Temperature Control Plan.
- Calculated maximum concrete temperature during curing based on expected conditions and methods used to control temperature.
- Proposed methods to control concrete temperature differentials during curing.
- Calculated maximum temperature differential based on expected conditions and methods used to control the temperature difference. Submit the thermal calculation model and/or computational software with the ThCP.
- Information on the temperature sensing and recording equipment to be used and drawings of locations of temperature sensors within each placement.
- Description of the format and frequency of providing temperature data.
- List of corrective measures to be taken to reduce excessive temperatures and temperature differences, if they occur.
- Description of curing methods and duration of curing.
- Description of formwork removal procedures and method to ensure that the temperature differences at exposed surfaces will not exceed the maximum concrete temperature differential.

5. Collection and Submittal of Measured Concrete Temperatures

The ThCP Engineer must personally inspect and approve the installation of temperature monitoring devices and verify that the process for recording temperature readings is effective for the first placement of each size and type of mass concrete element. Submit to the Engineer for approval the qualification of all technicians employed to inspect or monitor mass concrete placements. For placements other than the first, designate an employee or employees approved by the ThCP Engineer, as qualified to inspect monitoring device installation, to record temperature readings, to be in contact at all times with the ThCP Engineer if adjustments must be made as a result of the maximum concrete temperature limit or maximum concrete temperature difference limit being exceeded, and to immediately implement adjustments to temperature control measures as directed by the ThCP Engineer.

The Contractor shall notify the Engineer when the concrete temperature comes within 15 °F {8 °C} of the maximum in-place temperature limit or when the concrete temperature difference comes within 10 °F {6 °C} of the maximum in-place concrete temperature differential limit, and immediately take corrective measures to comply with the concrete temperature requirements of this specification.

The Contractor shall submit to the Engineer within three (3) days of completion of monitoring of each mass concrete element a copy of all measured temperature readings and include the measured maximum concrete temperature and maximum concrete temperature difference.

510.04 Acceptance of Mass Concrete

Construction shall not proceed on any mass concrete element until compliance with this specification has been determined and the Contractor has received written notification to continue construction from the State Construction Engineer.

If the Contractor fails to conform to any of the above temperature requirements in any one pour, the construction of any additional mass concrete elements will cease. The State Construction Engineer may, at his sole discretion, direct that the concrete be removed or otherwise mitigated, at no cost to the Department. The contractor shall revise the ThCP to correct the problem and resubmit the revised ThCP to the State Materials and Tests Engineer for acceptance for completeness. Mass concrete placement shall not begin until the State Materials and Tests Engineer has approved the revised ThCP. No extension of time or compensation will be made for any rejected mass concrete element or revisions of the ThCP.

510.05 Method of Measurement.

(a) General.

The quantities of concrete, steel reinforcement, structural steel, timber, piling, and other various contract pay items which constitute the completed and accepted structure shall, unless otherwise provided herein, be measured for payment according to the specifications for the individual contract pay items provided.

Accepted work, constructed to the dimensions shown on the plans or ordered in writing, will be used to determine the quantities of the respective pay items involved, all in accordance with the provisions of the applicable Section of these specifications.

Attention is directed to the major items of work such as Section 502 for Reinforcing Steel, Section 508 for Structural Steel, Section 509 for Timber, Section 505 for Piling, etc.

(b) Item 510-A and 510-B.

1. Volumetric Measure.

The volume of accepted concrete within the neat lines of the structure as shown on the plans or revised at the written direction of the Engineer will be computed in cubic yards {cubic meters}. The method of average end areas will not be used where results obtained differ from those obtained by more accurate mathematical computation.

2. Deductions.

No deduction will be made for the volume of concrete displaced by steel reinforcement, drainage scuppers, weep holes, service pipes, conduits, anchor bolts, castings of grillages, or structural shapes and plates. No deductions will be made for chamfers of less than 3 inch {75 mm} leg measurements.

The volume of precast concrete or timber pile heads imbedded in concrete will be deducted.

3. Additional Cement or Concrete Used.

No payment will be made on account of additional cement used or additional volume of concrete used unless ordered in writing. No payment will be made for footing concrete used outside line drill limits or other neat lines shown on the plans, where no forms are used. Additional cement ordered used will be paid for as described in Section 501.

(c) Item 510-C.

Each accepted Bridge Concrete Superstructure unit will be measured for payment as a lump sum unit. Partial payments will be allowed on monthly estimates in accordance with Subarticle 510.05(c).

(d) Item 510-E.

Grooving of bridge decks, acceptably completed in accordance with Subitem 510.03(c)6.c., will be measured by the square yard {square meter}.

(e) Item 510-G.

Each accepted Substructure Mass Concrete unit will be measured by the cubic yard {cubic meter} in accordance with the method of measurement that applies to this element type as defined in either Article 503.04 or Item 510.05.

(f) Item 510-H

Each accepted Superstructure Mass Concrete unit will be measured for payment as a lump sum unit.

510.06 Basis of Payment.

(a) Unit Price Coverage.

The accepted structural concrete, measured as noted above, will be paid for under the respective unit price bid for the appropriate item or items provided for such in the proposal. Said unit price bid shall be full compensation for the concrete, complete in place, which shall be payment in full for all

backfilling, compacting, disposal of surplus material, all falsework piling, falsework, forms, bracing, all materials except as specified below, and for all equipment, tools, labor, and incidentals necessary to finish and complete the items in accordance with the plans and these specifications. Non-metal expansion joints, scuppers and drains, electrical conduit and equipment, shall be included in the bid price for the concrete, unless otherwise provided on the plans or in the proposal. Steel reinforcement, metal expansion joints, and metal bearings will not be included in the price bid for the concrete but shall be paid for under the appropriate pay item. In case of widening or extension of an existing structure, the breaking away of existing concrete to the approximate lines shown on the plans and disposing of broken concrete and preparing steel reinforcement for splicing as required, will be paid for under Section 206.

The accepted mass concrete, measured as noted above, will be paid for in accordance with the unit price coverage that applies to this element type as defined in either Article 503.05 or Item 510.06. The development of the TCP and all equipment, tools, labor, and incidentals necessary to control concrete temperatures shall be included in the bid price for the concrete. All equipment, tools, labor, and incidentals necessary to measure and monitor the in-place concrete temperature as required herein shall be included in the bid price for the concrete.

No additional compensation will be allowed for constructing or placing expansion joints, scuppers, drains, weep holes, or for placing service pipes or conduits, anchor bolts, plates, castings, grillages, or metal bearings or appurtenances, as such are considered incidental to the placing of concrete or other items of the work, unless otherwise noted by the plans or proposal. Payment for grooving concrete bridge decks will be made at the contract unit price bid per square yard {square meter} which will be full compensation for furnishing the necessary equipment, tools, and labor to perform the work.

(b) Items 510-A and 510-B.

Payment for concrete measured on a cubic yard {cubic meter} basis as described above will be made at the contact unit price per cubic yard {cubic meter}, complete in place, for the various classes of concrete listed on the plans and the proposal.

(c) Item 510-C.

Payment for each accepted Bridge Concrete Superstructure unit will be made at the contract lump sum price bid for each unit, complete in place.

Partial payments will be made on monthly estimates based on the percentage of the total work performed on each unit as estimated by the Engineer.

The number of cubic yards {cubic meters} shown on the plans and in the proposal is approximate only and the lump sum amount bid for each unit will not be increased or decreased except as outlined below.

Structural steel, reinforcement and precast-prestressed concrete units are covered by other pay items.

An increase, or decrease, in the approximate quantity of surface deck area for bridge concrete superstructure required from that shown on the plans which is caused by a design change after the contract has been let will result in an increase, or decrease, in the compensation due the Contractor. This compensation will be made, either increase or decrease, as a proportional amount of the contract bid price of Item 510-C.

For any other changes in the approximate quantity of bridge concrete superstructure, price adjustments will be made in accordance with Article 104.02.

(d) Item 510-G

Payment for concrete measured on a cubic yard {cubic meter} basis as described above will be made at the contact unit price per cubic yard {cubic meter}, complete in place, for the various classes of concrete listed on the plans and the proposal.

(e) Item 510-H

Payment for each Superstructure Mass Concrete unit will be made at the contract lump sum price bid for each unit, complete in place.

The number of cubic yards {cubic meters} shown on the plans and in the proposal is approximate only and the lump sum amount bid for each unit will not be increased or decreased.

(f) Payment will be made under Item No.:

510-A Bridge Substructure Concrete - per cubic yard {cubic meter}
510-B Bridge Concrete, Class ___ - per cubic yard {cubic meter}
510-C Bridge Concrete Superstructure, __*, __**, __*** - per lump sum

510-E Grooving Concrete Bridge Decks - per square yard {square meter}
510-G Mass Bridge Concrete Substructure - per cubic yard {cubic meter}
510-H Mass Bridge Concrete Superstructure, __*, __**, ***** - per lump sum

* Station Number, Bridge Identification Number (BIN), Ramp Number, etc.

** Lane, if applicable

*** Approximate quantity of superstructure concrete in cubic yards {cubic meters}

SECTION 511
ELASTOMERIC BEARINGS

511.01 Description.

This Section shall cover the work of furnishing and installing elastomeric bearings for all types of bridge girders. An elastomeric bearing shall consist of at least a single layer of elastomer and may consist of a possible combination of elastomeric layer(s), internal steel sheet laminate(s), PTFE layer, bearing and/or sole plates, and a stainless steel plate.

511.02 Materials.

Elastomeric bearings shall be fabricated to conform with the material requirements given on the Plans and in Section 837.

511.03 Construction Requirements.

Unless noted otherwise on the plans or in these specifications, Shop Drawings for the elastomeric bearings shall be submitted to the Bridge Engineer for approval. Shop Drawings will not be required for the elastomeric bearings for precast concrete bridge components furnished under Section 512.

The elastomeric bearings will be identified on the plans by Type (Type 1, 2, 3, 4, or 5) and may be further identified by a Mark (Mark B1, B2, VB1, etc.).

Rust that occurs on the portions of bearing plates that are left ungalvanized for welding shall be cleaned to bare metal prior to welding. All exposed surfaces of the sole plate, all uncoated surfaces of the bearing plate and all weld metal shall be coated after welding with galvanizing repair paint that meets the requirements given in SECTION 855.

511.04 Method of Measurement.

The elastomeric bearings will be measured per each for each type of bearing. The bearings measured for payment do not include the randomly selected samples for testing.

511.05 Basis of Payment.

(a) Unit Price Coverage.

The unit price bid per bearing shall include all costs for equipment, materials (including bearing plates, sole plates, PTFE, and stainless steel plates), cleaning, painting, labor, bearings furnished for sampling and testing, shop drawings, and all incidentals necessary to furnish and install the complete bearing assembly.

(b) Payment will be made under Item No.:

511-A Elastomeric Bearing Type __* (Mark __**) - per each

* Bearing Type (1, 2, 3, 4, or 5)

** Optional Bearing Mark (B1, B2, VB1, etc.)

SECTION 512
PRECAST NON-PRESTRESSED CONCRETE BRIDGE MEMBERS

512.01 Description.

This Section shall cover the work of furnishing and installing precast non-prestressed concrete bridge members.

512.02 Materials.

(a) ALDOT Procedure.

Material requirements for the production of precast non-prestressed concrete bridge members are given in this Section and also in ALDOT-367 "Production and Inspection of Precast Non-Prestressed and Prestressed Concrete".

(b) Reinforcing Steel.

Reinforcing steel shall meet the requirements given in SECTION 835. Reinforcing steel shall be Grade 60 {Grade 420}.

(c) Concrete Mixture Requirements.

1. General.

The precast concrete producer shall establish the proportion of materials following the guidelines given in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete" and ALDOT-367, “Production and Inspection of Precast Non-Prestressed and Prestressed Concrete”.

The concrete producer shall submit the proposed concrete mixture proportions to the Materials and Tests Engineer for approval following the guidelines given in ALDOT-170. The distribution of the approved concrete mixture shall be in accordance with the requirements given in ALDOT-170 and ALDOT-367. Any changes of the materials and/or proportions of the approved concrete mixture, excluding chemical admixture dosages, shall require a concrete mixture re-submittal and approval.

2. Concrete Compressive Strength.

The 28-day compressive strength of bridge substructure members (bent caps, abutment caps, panels, etc.) shall be 3000 psi {21 MPa} unless the 28-day compressive strength is shown otherwise on the plans.

The 28-day compressive strength of bridge superstructure members (deck, curb, barrier rail, etc.) less than 20 feet {6 meter} in length shall be 4000 psi {28 MPa} unless the 28-day compressive strength is shown otherwise on the plans.

The 28-day compressive strength of bridge superstructure members (deck, curb, barrier rail, etc.) 20 feet {6 meter} and over in length shall be 5000 psi {35 MPa} unless the 28-day compressive strength is shown otherwise on the plans

3. Conventional Concrete Mixture Design Requirements.

The mixture design shall be based on the following requirements:

REQUIRED DESIGN PROPERTIES OF CONVENTIONAL CONCRETE MIXTURES	
Property	Requirement
Minimum Cementitious Factor (Lbs/Yd^3) {kg/m^3}	550 {330}
Maximum Water/Cementitious Material Ratio	0.45
Maximum Slump (prior to admixture) (in) {mm}	4.0 {100}

The maximum allowable total air content is 6.0 % by volume. The concrete mixture design shall be based on a target total air content of 4.5 %.

Chemical Admixtures for the production of conventional concrete shall be selected from List II-1 of the Department’s "Materials, Sources, and Devices with Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list. Chemical admixtures may be used to increase the slump of the concrete to a maximum of 9 inches {225 mm} if this is proposed in the mixture design submittal and approved for inclusion in the mixture. The approved water/cementitious material ratio shall not be exceeded in order to increase the slump.

4. Self-Consolidating Concrete Mixture Design Requirements.

Self-consolidating concrete (SCC) for the production of precast non-prestressed concrete bridge members shall meet the additional requirements of this Item. SCC is utilized to fill the formwork and encapsulate the reinforcing steel without, or with only minimal, applied vibratory consolidation.

The concrete producer shall establish the SCC mixture proportion in accordance with the guidelines given in ALDOT 170 with the exception that the producer shall determine the SCC mixture proportion to meet the required design properties given in the following table.

REQUIRED DESIGN PROPERTIES OF SCC MIXTURE Properties shall be measured from a minimum size batch of 3 cubic yards {2 cubic meters}.	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall meet Item 512.02(c)2.
Cementitious Materials Content	Minimum 600 lb/yd^3 {355 kg/m^3} of concrete.
Water/Cementitious Materials Ratio	Maximum 0.45.
Nominal Aggregate Size	Maximum ¾ inches {20 millimeters}.
Fine/Total Aggregate Ratio	0.45 to 0.55 by volume.
Total Air Content	Maximum 6.0 % by volume. The design of the mixture shall be based on a target total air content of 4.5 %.
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367.
Slump Flow[1]	Minimum 25 inches {635 millimeters} and maximum 29 inches {735 millimeters}.
Passing Ability[1]	Difference between slump flow and J-Ring flow 3.0 inches {75 millimeters} or less.
Stability[1]	VSI 1.0 or less.
Robustness	Slump flow 29 inches {735 millimeters} or less and VSI 1.0 or less.
NOTE: 1. Test shall be completed within 10 minutes after completion of mixing.	

Chemical Admixtures for the production of SCC shall be selected from List II-1 of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list. Approved viscosity modifying admixtures (VMA) may be used as a part of the chemical admixtures if they are shown in the approved mixture design.

5. Cementitious Materials.

The cementitious materials used in the concrete mixture shall meet the requirements given in Sections 806 and 815. Fly ash, ground granulated blast furnace slag, and microsilica can be substituted for a portion of portland cement. Various options of maximum percent allowable mineral admixture substitutions for portland cement are defined in the following table.

MAXIMUM PERCENT OF ALLOWABLE MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT (BY WEIGHT)			
Substitution Option	Class C or Class F Fly Ash	Ground Granulated Blast Furnace Slag	Microsilica
1	30 %	-	-
2	-	50 %	-
3	-	-	10 %
4	20 %	-	10 %
5	20 %	30 %	-

512.03 Construction Requirements.

(a) Manufacturing Plant and Personnel Requirements.

The precast concrete bridge member manufacturing plant shall be certified by either the Precast/Prestressed Concrete Institute (PCI) Plant Certification Program or the National Precast Concrete Association (NPCA) Plant Certification Program. Certification of plants under PCI shall be at least Category B1 (Precast Bridge Products). The manufacturer shall submit proof of the plant certification to the Materials and Tests Engineer prior to the start of production.

The manufacturing plant shall have on site, at the time of manufacturing bridge components for ALDOT, at least one technician that is certified as an ALDOT Concrete Technician. This technician shall

also have a NPCA certification or be certified as PCI Level I/II. The manufacturer shall submit proof of this certification to the Materials and Tests Engineer prior to the start of production and during production when required by the Engineer.

The manufacturer's laboratory and laboratory personnel shall be qualified in accordance with the requirements given in ALDOT-405, "Certification and Qualification Program for Concrete Technicians and Concrete Laboratories".

(b) Concrete Testing.

The producer's Quality Control (QC) technician shall be responsible for concrete Sampling and testing. The QC technician shall determine and document the point of sampling and testing and the testing schedule for each line of production. Sampling and testing shall be done as close as possible to the casting bed and in accordance with the requirements of ALDOT-367.

1. Conventional Concrete Testing Requirements During Production.

Conventional concrete shall be in compliance with the requirements given in the following table during production.

REQUIRED PROPERTIES OF CONVENTIONAL CONCRETE MIXTURES DURING PRODUCTION	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall meet Item 512.02(c)2
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367
Total Air Content	Maximum 6.0 % by volume.
Slump	Maximum 4.0 in {100 mm} without chemical admixtures Maximum 9.0 in {225 mm} with chemical admixtures

2. SCC Testing Requirements During Production.

SCC shall be in compliance with the requirements given in the following table during production.

REQUIRED PROPERTIES OF THE SCC MIXTURE DURING PRODUCTION	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall meet Item 512.02(c)2.
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367.
Total Air Content	Maximum 6.0 % by volume.
Slump Flow	Minimum 25 inches {635 millimeters} and maximum 29 inches {735 millimeters}.
Stability	VSI 1.0 or less, or Sieved fraction 7.5 % or less for gradation with ½" nominal aggregate size or smaller, or sieved fraction 15 % or less for gradation with ¾" nominal aggregate size. [1]
NOTE: 1. The sieve fraction is determined by the Sieve Stability Test in accordance with ALDOT-452.	

(c) Surface Finish Of Precast Bridge Members.

The roadway surface of bridge deck span sections shall be finished with either a wood float finish or with a broom finish done with a broom with medium to stiff bristles. A broom finish shall be applied in a transverse direction and shall penetrate the surface approximately 1/8 of an inch.

Curb and barrier rail sections shall have a Class 3 surface finish in accordance with the requirements given in Section 501. All other surfaces shall have a Class 1 surface finish in accordance with the requirements given in Section 501.

(d) Handling, Storing, and Transporting Members.

The Contractor shall be fully responsible for handling, storing and transporting precast concrete bridge members in a manner that will prevent damage to the members.

Members shall be lifted and stored in an upright position. Lifting hooks or similar devices for lifting shall be placed at points close to each end of each member or at the locations shown on the plans. Devices shall be of sufficient strength and embedment to provide safe handling of the members. Blocking under units during storage and handling shall be placed to prevent damage.

Precast concrete bridge members shall be held at the plant for a minimum of 4 days after casting. Precast concrete bridge members shall not be transported until the minimum 28-day compressive strength is obtained and verified by test cylinders.

(e) Installation of Precast Bridge Members.

1. Damaged Members.

Members that are damaged in any way shall be replaced or repaired without extra compensation.

2. Installation of Deck Members.

Deck members shall be installed so that the difference in the surface of the deck across adjacent members does not exceed 1/4 of an inch {6 mm}. Deck members shall be replaced without extra compensation if the difference in the surface is not within the allowable 1/4 of an inch {6 mm} difference. Members not meeting the installation tolerance may be installed in other locations in the structure if this results in an acceptable deck surface.

Deck members shall be bolted together as shown on the plans to provide snug tight fit. Beveled washers shall be provided if the flat washers, bolt heads and nuts are not in full bearing on each other after tightening. Snug tight is defined as the tightness that can be produced by one or two solid blows from an impact wrench or by full effort of a person using an ordinary 2 foot {610 mm} spud wrench. The threads of the bolts shall be burred to prevent removal after the members have been acceptably bolted together.

The concrete keyway shall be filled with concrete after the members have been acceptably installed. The keyway shall be filled with a 1:2:3 concrete mixture, by weight {mass}, of cement, fine aggregate, and coarse aggregate, respectively. The maximum size of the coarse aggregate shall be 3/8 of an inch {9.5 mm}, and the maximum amount of water allowed shall be 6 gallons per 100 pounds {1 liter per 2 kg} of cement.. The keyways shall be filled in accordance with the following:

- Standard mixing of the concrete shall be completed a minimum of 45 minutes in advance of placement;
- The mixture shall be retempered by remixing the concrete without additional water just prior to placing;
- The concrete mixture shall be placed in the keyway, tamped, and packed as necessary to insure complete filling of the joint;
- The exposed surface of the newly place concrete keyway shall be struck to the same elevation as the adjacent deck sections;
- The surface shall be given a wood float finish
- The concrete keyway shall be cured as per Subarticle 501.03(j).

3. Installation of Bent and Abutment Caps.

All piling shall be properly aligned (transversely and longitudinally) prior to the establishment of the pile cutoff elevations.

Gaps anywhere between the cap anchor plate and the top of the pile are unacceptable without adequate correction. The Contractor shall submit a written procedure for providing a structurally acceptable connection when a gap is greater than 3/16 inch {4 mm}. The corrective procedure shall be submitted in accordance with the requirements for Working Drawings given in Article 105.02.

Where all gaps between the cap anchor plate and the top of the pile are less than or equal to 3/16 inch {4 mm}, attachment welds shall be provided in accordance with the requirements given in the following table.

WELD REQUIRED FOR THE ATTACHMENT OF PRECAST CONCRETE CAP ANCHOR PLATE TO THE TOP OF A STEEL PILE	
Size of Largest Gap Anywhere At Top of Pile	Size of Fillet Weld Required All Around the Top of the Steel Pile
Full Contact-No Gap	1/4 inch {6 mm} (per Standard Details on Plans)

Less Than or Equal to 1/16 inch {2 mm}	1/4 inch {6 mm} (per Standard Details on Plans)
Less Than or Equal to 1/8 inch {3 mm}	5/16 inch {8 mm}
Less Than or Equal to 3/16 inch {4 mm}	3/8 inch {10 mm}

The connection between the top of the pile and the steel plate embedded in the cap shall be made by a welder that is ALDOT certified 4F (qualified for fillet welding in the overhead position) using the manual Shielded Metal Arc Welding (SMAW) method. Welding shall be done in accordance with the requirements given in Section 836.

(f) Placement of Cranes on Bridge Decks.

Cranes shall not be placed on a bridge deck unless approved by the Engineer. The Contractor shall submit a placement plan for review prior to placing a crane on a bridge deck. The placement plan shall be submitted in accordance with the requirements given in Section 510.

(g) Pile Painting.

All exposed surfaces of piles shall be painted in accordance with the requirements given in Sections 505 and 521. The surface of the piling that is in contact with the abutment panels shall be painted with the coating applied to the other surfaces of the piling or with a System 3 coating if the abutment panels are installed prior to the painting of the other surfaces.

512.04 Method of Measurement.

Precast concrete bridge members will be measured per each for each type and size of member.

512.05 Basis of Payment.

(a) Unit Price Coverage.

A precast concrete member will be paid for at the contract unit price for the required type and size (depth, width, and length). This unit price shall be full compensation for manufacturing, delivery and installation, accessories, all items cast into the concrete, tie bolts, expansion materials, cover concrete over fittings, grout and grouting, surface finishing and for all other materials, equipment, labor, and incidentals required to make the bridge member a part of the completed bridge. Structural steel, handrail and bearings will be paid for under other items of work.

(b) Payment will be made under Item No.:

512-A Precast Concrete Abutment Caps, ____ Wide by ____ Deep by ____ Long - per each
512-B Precast Concrete Intermediate Bent Caps, ____ Wide by ____ Deep by ____ Long - per each
512-C Precast Concrete Type ____*__ Span Section, ____ Wide by ____ Deep by ____ Long - per each
512-D Precast Concrete __**__ Section, ____ Long - per each
512-E Precast Concrete Abutment Panels, Type ____ - per each
512-F Precast Concrete Wing Panels, Type ____ - per each
512-G Precast Concrete Abutment Wing Cap Panels - per each

* Types of Span Sections
Type 1 - Interior Span Section
Type 2A - Exterior Span Section for Curb A Section
Type 2B - Exterior Span Section for Curb B Section
Type 2C - Exterior Span Section for Barrier Rail
Type 2D - Exterior Span Section with Curb D Section
Type 2E - Exterior Span Section with Curb E Section

** Types of Sections
Curb A
Curb B
Barrier Rail Intermediate
Barrier Rail End

NOTE: See plan details for size, shape, dimensions, etc. of the various types of span, curbs, and barrier rail sections.

SECTION 513
PRESTRESSED CONCRETE BRIDGE MEMBERS

513.01 Description.

This Section shall cover the furnishing and installation of prestressed concrete bridge members. The required details of the members and the required details for the installation of the members in the structure will be shown on the plans.

513.02 Materials.

(a) ALDOT Procedure.

Material requirements for the production of precast prestressed concrete bridge members are given in this Section and also in ALDOT-367 "Production and Inspection of Precast Non-Prestressed and Prestressed Concrete".

(b) Reinforcing Steel and Prestressing Steel.

Reinforcing steel and prestressing steel shall meet the requirements given in SECTION 835. Reinforcing steel shall be Grade 60 {Grade 420}. Prestressing steel strands and bars shall be the type shown on the plans.

(c) Concrete Mixture Requirements.

1. General.

The prestressed concrete producer shall establish the proportion of materials following the guidelines given in ALDOT-170, "Method of Controlling Concrete Operations for Structural Portland Cement Concrete" and ALDOT-367, "Production and Inspection of Precast Non-Prestressed and Prestressed Concrete".

The prestressed concrete producer shall submit the proposed concrete mixture proportions to the Materials and Tests Engineer for approval following the guidelines given in ALDOT-170. The distribution of the approved concrete mixture shall be in accordance with the requirements given in ALDOT-170 and ALDOT-367. Any changes of the materials and/or proportions of the approved concrete mixture, excluding chemical admixture dosage, shall require a concrete mixture re-submittal and approval.

The 28-day compressive strength for prestressed concrete bridge members shall be 5000 psi {35 MPa} or the 28-day compressive strength shown on the plans.

2. Conventional Concrete Mixture Design Requirements.

The mixture design shall be based on the following requirements:

MIXTURE DESIGN CRITERIA	ALL MEMBERS
Minimum Cementitious Factor (Lbs/Yd^3) {kg/m^3}	550 {330}
Maximum Water/Cementitious Material Ratio	0.45
Maximum Slump (prior to admixture) (in) {mm}	4.0 {100}

The maximum allowable total air content is 6.0 % by volume. The concrete mixture design shall be based on a target total air content of 4.5 %.

Chemical admixtures may be used to increase the slump of the concrete to a maximum of 9 inches {225 mm} if this is proposed in the concrete mixture design submittal and approved for inclusion in the mixture. The approved water-to-total cementitious material ratio shall not be exceeded in order to increase the slump.

3. Self-Consolidating Concrete Mixture Design Requirements.

Self-consolidating concrete (SCC) for the production of prestressed concrete members (including piles) shall meet the additional requirements of this Item. SCC is utilized to fill the formwork and encapsulate the reinforcing steel without, or with only minimal, applied vibratory consolidation.

The concrete producer shall establish the SCC mixture proportion in accordance with the guidelines given in ALDOT 170 with the exception that the producer shall determine the SCC mixture proportion to meet the required design properties given in the following table.

REQUIRED DESIGN PROPERTIES OF THE SCC MIXTURE Properties shall be measured from a minimum size batch of 3 cubic yards {2 cubic meters}.	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall be 5,000 psi {35 MPa} or the compressive strength shown on the plans.
Cementitious Materials Content	Minimum 600 lb/yd^3 {355 kg/m^3} of concrete.
Water/Cementitious Materials Ratio	Maximum 0.40.
Nominal Aggregate Size	Maximum ¾ inches {20 millimeters}.
Fine/Total Aggregate Ratio	0.45 to 0.55 by volume.
Total Air Content	Maximum 6.0 % by volume. The design of the mixture shall be based on a target total air content of 4.5 %.
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367.
Drying Shrinkage	Maximum of 0.04 % after 28 days of drying.
Slump Flow[1]	Minimum 25 inches {635 millimeters} and maximum 29 inches {735 millimeters}.
Passing Ability[1]	Difference between slump flow and J-Ring flow 3.0 inches {75 millimeters} or less.
Stability[1]	VSI 1.0 or less.
Robustness	Slump flow 29 inches {735 millimeters} or less and VSI 1.0 or less.
NOTE: 1. Test shall be completed within 10 minutes after completion of mixing.	

Chemical Admixtures for the production of SCC shall be selected from List II-1 of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list. Approved viscosity modifying admixtures (VMA) may be used as a part of the chemical admixtures if they are shown in the approved mixture design.

4. Cementitious Materials.

The cementitious materials used in the prestressed concrete mixture shall meet the requirements given in Sections 806 and 815. Fly ash, ground granulated blast furnace slag, and microsilica can be substituted for a portion of portland cement. Various options of maximum percent allowable mineral admixture substitutions for portland cement are defined in the following table.

MAXIMUM PERCENT OF ALLOWABLE MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT (BY WEIGHT)			
Substitution Option	Class C or Class F Fly Ash	Ground Granulated Blast Furnace Slag	Microsilica
1	30 %	-	-
2	-	50 %	-
3	-	-	10 %
4	20 %	-	10 %
5	20 %	30 %	-

5. Special Requirements for Piles constructed in Severe Exposure Conditions.

Piles constructed in a marine environment, within 10 miles {16 kilometers} from coastline, completely or partially submerged in seawater, located within the tidal and splash zones, exposed to seawater spray, exposed to brackish water, or as shown on the plans shall meet the requirements of this Item.

Cement for piles shall be Type II and thus low in tricalcium aluminate content. If requested by the Contractor and approved by the Materials and Tests Engineer, Type I or Type III cement containing a maximum of 8 % tricalcium aluminate may be used.

Concrete mixtures used in piles shall have a maximum permeability of 2,000 coulombs.

The concrete for piles shall contain Class "F" fly ash and microsilica as components of the cementitious material. The required percentage of fly ash and microsilica by weight {mass} of the total cementitious material content shall be as follows:

CEMENTITIOUS MATERIAL CONTENT IN PILES	
Cement (Type II)	70 %
Fly Ash (Class “F”)	20 %
Microsilica	10 %
Total Cementitious Materials Content	100 %

513.03 Construction Requirements.

(a) Manufacturer's Plant, Laboratory and Personnel Requirements.

The concrete bridge member manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute (PCI) Plant Certification Program. Certification of the production plants shall be Category B4 (Prestressed Deflected Strand Bridge Members). The manufacturer shall submit proof of the plant certification to the Materials and Tests Engineer prior to the start of production.

The manufacturing plant shall have on site, at the time of manufacturing bridge components for ALDOT, at least one technician that is certified as an ALDOT Concrete Technician. This technician shall also be certified as PCI Level I/II. The manufacturer shall submit proof of this certification to the Materials and Tests Engineer prior to the start of production and during production when required by the Engineer.

The manufacturer's laboratory and laboratory personnel shall be qualified in accordance with the requirements given in ALDOT-405, "Certification and Qualification Program for Concrete Technicians and Concrete Laboratories".

(b) Shop Drawings and Notification of Manufacturer.

The Contractor shall submit shop drawings to the Bridge Engineer for approval prior to production. The complete details of prestressed concrete members shall be submitted as Shop Drawings in accordance with the requirements given in Article 105.02. The submittal shall include the proposed tensioning and de-tensioning procedures.

Within 30 days after the award of the contract, the Contractor shall notify the Materials and Tests Engineer in writing of the name and address of the manufacturer of the prestressed concrete bridge members. The notification shall include the manufacturer's proposed fabrication schedule.

(c) Concrete Testing.

Sampling and testing shall be done in accordance with the requirements of ALDOT-367. The Department’s inspector will determine the point of sampling and testing schedule for each line of production.

Sampling and testing shall be performed as close as possible to the casting bed in the presence of a Department inspector.

1. Conventional Concrete Testing Requirements during Production.

Conventional concrete shall be in compliance with the requirements given in the following table during production.

REQUIRED PROPERTIES OF CONVENTIONAL CONCRETE MIXTURES DURING PRODUCTION	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall be 5,000 psi {35 Mpa} or the compressive strength shown on the plans.
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367
Total Air Content	Maximum 6.0 % by volume.
Slump	Maximum 9 inches if chemical admixtures are used.

2. SCC Testing Requirements during Production.

SCC shall be in compliance with the requirements given in the following table during production.

REQUIRED PROPERTIES OF THE SCC MIXTURE DURING PRODUCTION	
Property	Requirement
Compressive Strength at 28 days	The compressive strength shall be 5,000 psi {35 MPa} or the compressive strength shown on the plans.
Temperature	Freshly mixed concrete temperature as limited in ALDOT-367.
Total Air Content	Maximum 6.0 % by volume.
Slump Flow	Minimum 25 inches {635 millimeters} and maximum 29 inches {735 millimeters}.
Stability	VSI 1.0 or less, or Sieved fraction 7.5 % or less for gradation with ½" nominal aggregate size or smaller, or sieved fraction 15% or less for gradation with ¾" nominal aggregate size. 1
NOTE: 1. The sieve fraction is determined by the Sieve Stability Test in accordance with ALDOT-452.	

(d) Camber of Girders and Bridge Deck Spans.

The theoretical camber of girders will be shown on the plans. The camber of girders shall be a minimum of ½ inch {13 mm} at the time of shipment. The camber of span sections shall be a minimum of ¼ inch {6 mm} at the time of shipment.

(e) Surface Finish.

All surfaces shall, except as noted below in this Subarticle, have a Class 1 surface finish in accordance with the requirements given in Section 501.

The outside of all exterior girders shall have a Class 2 surface finish in accordance with the requirements given in Section 501 if a Class 3 is not shown to be required on the plans. The final Class 2 finish shall not be applied until after the completion of the construction of the bridge deck on the girders.

A Class 2 surface shall be applied to the final exposed surface of concrete piles if shown to be required on the plans.

Girder top surfaces shall be intentionally roughened with transverse grooves that penetrate the concrete surface to a minimum depth of ¼ of an inch {6 mm} spaced at no more than ½ of an inch (13 mm) in the hardened concrete.

Riding surfaces, cast integrally as part of the precast member, for example in bridge deck span sections, shall be finished with either a wood float finish or with a broom finish done with a broom with medium to stiff bristles. A broom finish shall be applied in a transverse direction and shall penetrate the surface approximately ⅛ of an inch. Surfaces of precast bridge deck span sections that will be bonded to an overlay shall be raked in a transverse direction to provide a roughened surface for the application of the overlay. The roughened surface shall have a minimum of ¼ inch {6 mm} ridges raised in the hardened concrete.

(f) Handling, Storing, and Transporting Members.

The Contractor shall be fully responsible for handling, storing and transporting prestressed concrete bridge members in a manner that will prevent damage to the members.

Girders shall be handled and stored in an upright position. Lifting hooks or similar devices for lifting shall be placed at points close to each end of each member or at the locations shown on the plans. Devices shall be of sufficient strength and embedment to provide safe handling of the members. Blocking under units during storage and handling shall be placed to prevent damage.

Piles shall be lifted, stored, transported, and placed in the pile driving leads in a manner that will eliminate the possibility of damaging bending stresses, cracking and spalling. Piles shall be lifted by means of a suitable bridle or sling attached to the pile at pickup points designated on the plans. Cracked piles will be rejected and shall be immediately removed and replaced without additional compensation.

All prestressed concrete bridge members except piles shall be held at the plant for a minimum of 4 days after casting. Piles shall be held at the plant for a minimum of 21 days after casting. All prestressed concrete bridge members shall not be transported until the minimum 28-day compressive strength is obtained and verified by test cylinders.

(g) Installation of Prestressed Concrete Members.

1. Damaged Members.

   Members that are damaged in any way shall be replaced or repaired without extra compensation.

2. Prestressed Concrete Girders.

   Prestressed girders shall be lifted by attachment at the lifting points shown on the shop drawings. Girders shall be supported at the bearing points shown on the plans when they are put into the structure.

   The Contractor shall be fully responsible for the stability of the girders during construction. The Contractor shall submit working drawings in accordance with the requirements given in Article 105.02 for temporary bracing installed to provide stability for the girders.

3. Installation of Deck Span Members.

   Deck span members that will not be covered by an overlay shall be installed so that the difference in the top surface of adjacent members does not exceed 1/4 of an inch {6 mm}. Deck members shall be replaced without extra compensation if the difference in the surface is not within the allowable 1/4 of an inch {6 mm} difference. Members not meeting the installation tolerance may be installed in other locations in the structure if this results in an acceptable deck surface.

   Deck span members shall be bolted together as shown on the plans to provide snug tight fit. Beveled washers shall be provided if the flat washers, bolt heads and nuts are not in full bearing on each other after tightening. Snug tight is defined as the tightness that can be produced by one or two solid blows from an impact wrench or by full effort of a person using an ordinary 2 foot {610 mm} spud wrench. The threads of the bolts shall be burred to prevent removal after the members have been acceptably bolted together.

   At the completion of the bolting together of the members, the concrete keyway shall be filled with a 1:2:3 concrete mixture, by weight {mass}, of cement, fine aggregate, and coarse aggregate, respectively. The maximum size of the coarse aggregate shall be 3/8 of an inch {9.5 mm}, and the maximum amount of water allowed shall be 6 gallons per 100 pounds {1 liter per 2 kg} of cement. The keyways shall be filled in accordance with the following:

   - Standard mixing of the concrete shall be completed a minimum of 45 minutes in advance of placement;
   - The mixture shall be retempered by remixing the concrete without additional water just prior to placing;
   - The concrete mixture shall be placed in the keyway, tamped, and packed as necessary to insure complete filling of the joint;
   - The exposed surface of the newly placed concrete keyway shall be struck to the same elevation as the adjacent deck sections;
   - The surface shall be given a wood float finish.
   - The concrete keyway shall be cured as per Subarticle 501.03(j).

(h) Placement of Cranes on Bridge Decks.

Cranes shall not be placed on a bridge deck unless approved by the Engineer. The Contractor shall submit a placement plan for review prior to placing a crane on a bridge deck. The placement plan shall be submitted in accordance with the requirements given in Section 510.

513.04 Method of Measurement.

(a) Item No. 513-A.

Girders will be measured per each girder of each type and length.

(b) Item No. 513-B.

Each type of girder will be measured per linear foot of casting length shown on the approved shop drawings minus the length of elastic shortening and shrinkage. This will be the length recorded on the Shipping Notice (BMT-139) prepared by the Department's Plant Inspector. A copy of BMT-139 shall be sent with the shipment of the girders.

(c) Items 513-C and 513-D.

Concrete span sections will be measured per each type and size.

513.05 Basis of Payment.

(a) Unit Price Coverage.

1. Items 513-A and 513-B.

Concrete girders will be paid for at the contract unit price for each type of girder. This price shall be full compensation for furnishing all materials, accessories, tools and labor necessary to manufacture and install the girders.

This price shall also be full compensation for premolded bituminous filler, for all items cast into the concrete including metal bearing plates and studs welded to these plates, and for obtaining a Class 2 surface finish on the outside of all exterior girders.

2. Items 513-C and 513-D.

Concrete deck span sections will be paid for at the contract unit price for each type and size. This price shall be full compensation for furnishing all materials, accessories, tools and labor necessary to manufacture and install the span sections.

This price shall also be full compensation for all items cast into the concrete, for the tie bolts, for expansion and bearing materials, for cover concrete over fittings, for grout and grouting, for placement of keyways, and for surface finishing. Other structural steel items and handrail will be covered under other items of work.

3. Partial Payment.

Partial payments will be made in accordance with the following schedule:

- Fabrication and delivery to approved storage site. (Approved storage sites and partial payment for stored materials are addressed in Article 109.07);
- Erected and the required finish applied to girder units or the bolting up and casting of Keyway on Deck Units - 100%.

Partial payments for members that are unacceptable because of damage, improper installation or any other reason will be recovered by the Department on the next monthly estimate or final estimate, whichever is applicable.

(b) Payment will be made under Item No.:

513-A ___* Pretensioned-prestressed Concrete Girders, Type __**
(SPECIALTY ITEM) - per each

513-B Pretensioned-prestressed Concrete Girders, Type __**
(SPECIALTY ITEM) - per linear foot {meter}

513-C Prestressed Concrete Interior Span Sections, _____ Wide by _____ Deep by _____ Long
(SPECIALTY ITEM) - per each

513-D Prestressed Concrete Exterior Span Sections, _____ Wide by _____ Deep by _____ Long
(SPECIALTY ITEM) - per each

* Length

** Type I, II, III, etc.

SECTION 515
WATERPROOFING AND DAMPPROOFING

515.01 Description.

(a) General.

This Section shall cover the work of furnishing and applying a waterproofing or dampproofing surface to concrete in accordance with the methods prescribed for the several classes of waterproofing or dampproofing described below, each to be applied where called for on the plans and in conformity with the requirements of these Specifications.

(b) Methods.

The following four classes of waterproofing and one of dampproofing are covered by these Specifications:

1. Class A Waterproofing.
   Prime coat, mop coat of hot asphalt, and 2 alternate layers of fabric and moppings of hot asphalt.
2. Class B Waterproofing.
   Prime coat, mop coat of hot asphalt, and 2 alternate layers of fabric and moppings of hot asphalt with a mortar protection course.
3. Class C Waterproofing.
   Prime coat, mop coat of hot asphalt, and 2 alternate layers of fabric and moppings of hot asphalt with an asphalt plank protection course.
4. Class D Waterproofing.
   Manufactured waterproofing products.
5. Dampproofing.
   Prime coat and 2 mop coats of hot asphalt.

515.02 Materials.

(a) General.

All materials shall conform to the provisions of Division 800, Materials. Specific reference is made to the following:

Section 802, Fine Aggregates.
Section 805, Mineral Filler.
Section 815, Cement.

(b) Primer.

Primer used with asphalt mop coats shall meet the requirements of ASTM D 41.

(c) Mop Coat.

Asphalt for mop coat shall meet the requirements of ASTM D 449, Type I, II, or III as designated by plan details; however, unless otherwise designated, Type II shall be used.

(d) Water Proofing Fabrics.

Waterproofing fabric shall be woven cotton fabric meeting requirements of ASTM D 173.

(e) Asphalt Plank.

Asphalt plank shall be in accordance with requirements of ASTM D 517.

(f) Class D Waterproofing Materials.

All Class D Waterproofing materials furnished by the Contractor for use shall be listed on List II-10, WATERPROOFING MATERIALS, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

Class D waterproofing materials shall meet the requirements given in the following table.

REQUIRED PHYSICAL PROPERTIES FOR CLASS D WATERPROOFING MATERIALS		
Property	REQUIREMENTS	TEST METHOD
Thickness	0.065 of an inch minimum {1.5 mm minimum}	--
Permeance-PermsGrains/sq.ft./hr.,in.hg {57.2 ng/s•m2•Pa}	0.10 maximum {5.72 maximum}	ASTM E 96, Water Method at 73.4 ºF {23 ºC}
Tensile Strength	50 pounds/inch minimum {9 N/mm minimum}	ASTM D 882
Puncture Resistance (fabric)	200 lb. minimum {896 N minimum}	ASTM E 154
Pliability – 1/4" {6mm} Mandrel, 180º bend at -15 ºF {-26 ºC}	No cracks in fabric or rubberized asphalt	ASTM D 146

(g) Mortar for Protection Course.

Mortar for protection course shall be in accordance with requirements of Section 611.

515.03 Construction Requirements.

(a) Class A Waterproofing.

1. Preparation of Surface.

The surface to be waterproofed shall have cured for at least seven days and shall be reasonably smooth and free from projections or depressions which might cause puncture of the membrane. The surface shall be dry, so as to prevent the formation of steam when the hot asphalt is applied, and immediately before the application of the waterproofing, the surface shall be thoroughly cleaned of dust and loose material.

No waterproofing shall be done in wet weather nor when the temperature is below 60 ºF {15 ºC}, without special authorization from the Engineer.

2. Application.

The surface to be waterproofed shall be given a complete coat of primer which shall be permitted to set before the first mop coat is applied.

Asphalt shall be heated to a temperature between 300 ºF {150 ºC} and 350 ºF {175 ºC} with frequent stirring to avoid local overheating. Heating kettles shall be equipped with thermometers and oil jackets.

In all cases, the waterproofing shall begin at the low point of the surface to be waterproofed so that water will run over and not against or along the laps.

The first strip of fabric shall be of half width; the second shall be full width, lapped the full width of the first sheet; and the third and each succeeding strip shall be full width and lapped so that there will be two layers of fabric at all points with laps not less than 2 inches {50 mm} wide. All end laps shall be at least 12 inches {300 mm}.

Beginning at the low point of the surface to be waterproofed, a section of about 20 inches {500 mm} wide and the full length of the surface shall be mopped with the hot asphalt and there shall be rolled into it, immediately following the mop, the first strip of fabric, of half width, which shall be carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used shall then be mopped with hot asphalt and a full width of fabric shall be rolled into this, completely covering the first strip, and pressed into place as before. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip not less than 2 inches {50 mm}. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 2 inches {50 mm} over the second preceding strip. The entire surface shall then be given a final mopping of hot asphalt.

The completed waterproofing shall be a firmly bonded membrane, composed of an asphalt prime coat, a mopping of asphalt, and two alternating layers of fabric and moppings of asphalt. Under no circumstances shall one layer of fabric touch another layer at any point or touch the surface of concrete, as there must be at least three complete moppings of asphalt.

In all cases the mopping on concrete shall completely cover the surface and on cloth it shall be sufficiently heavy to completely conceal the weave. On horizontal surfaces not less than 12 gallons {5 L} of asphalt shall be used for each 100 square feet {each square meter} of finished work and on vertical surfaces not less than 15 gallons per 100 square feet {6 L/m^2} shall be used. The work shall be so regulated that at the close of a day's work all cloth that is laid shall have received the final mopping of asphalt. Special care shall be taken at all laps to see that they are completely sealed down.

3. Details.

At the edges of the membrane and at any points where it is punctured by such appurtenances as drains or pipes, suitable provisions shall be made to prevent water from getting between the waterproofing and the waterproofed surface.

All flashing at curbs and against girders, spandrel walls, et cetera, shall be done with separate sheets lapping the main membrane not less than 12 inches {300 mm}. Flashing shall be closely sealed either with a metal counter flashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.

Joints which are essentially open joints, but which are not designed to provide for expansion, shall be caulked with oakum and lead wool and then filled with an approved bituminous material before the membrane is placed.

Expansion joints, both horizontal and vertical, shall be provided with sheet copper in "U" or "V" form and premolded joint filler as called for on the plans. Expansion joints shall be sealed on the face adjacent to the membrane with an approved bituminous material. The membrane shall be carried continuously across all expansion joints.

At the ends of the structure the membrane shall be carried well down on the abutments and suitable provision made for all movement.

4. Damaged Membrane Patching.

Care shall be taken to prevent injury to the finished membrane. Any damage which may occur shall be repaired by patching, utilizing original waterproofing methods as set forth above. Patches shall extend at least 12 inches {300 mm} beyond the outermost damaged portion and the second ply shall extend at least 3 inches {75 mm} beyond the first.

5. Backfilling.

No backfilling shall be done without the permission of the Engineer, and in no case, until the final mop coat has hardened. Backfill shall be placed in such a manner that the waterproofing will not be damaged. No stones, broken concrete, bricks, or other material likely to damage the Membrane Shall Be Placed Adjacent To Waterproofed Surfaces.

(b) Class B Waterproofing.

In addition to the requirements for Class A Waterproofing noted in Subarticle (a) above, Class B Waterproofing shall require a mortar protection layer as follows:

Mortar Protection Layer.

Over the waterproofing membrane constructed as specified in Subarticle (a) above, there shall be constructed a protection layer which, unless otherwise specified or shown on the plans, shall be a 2 inch {50 mm} thickness of Portland cement mortar. This mortar layer shall be reinforced midway between its top and bottom surfaces with wire netting of 6 inch {150 mm} mesh and 12 gage {2.7 mm} wire or its approved equivalent. The top surface shall be troweled to a smooth, hard finish and, where required, true to grade.

On undercut surfaces (the underside of surfaces making an angle of less than 90° with a horizontal plane) the membrane shall be protected with a layer of 3-ply roofing felt laid in hot asphalt in lieu of the mortar covering. The asphalt used for this purpose shall be the same as that used in building up the membrane.

The construction of the protection course shall follow the waterproofing so closely that the latter will not be exposed without protection for more than 24 hours.

The protection course shall be cured in accordance with the requirements for curing concrete, Section 501.

No backfilling shall be done until the protection course has been in place seven days.

(c) Class C Waterproofing.

In addition to the requirements for Class A Waterproofing noted in Subarticle (a) above, Class C Waterproofing shall require an asphalt plank protection layer as follows:

Asphalt Plank Protection Layer.

Over the waterproofing membrane constructed as specified in Subarticle (a) above, there shall be constructed a protection layer of plain asphalt plank 1.25 inches {32 mm} thick, Whole planks, in regular, straight courses, shall be used except as required to make closures and trim around openings and obstructions. Closing and trimming pieces shall be carefully cut to size. The entire surface of the membrane shall be covered with the plank. Before laying, all surplus talc or other powder shall be removed from the plank with a stiff brush or broom. Each plank shall be laid in a mopping of hot asphalt and the edge and end of planks in place shall be coated with hot asphalt before the next plank is placed. The asphalt used for this purpose shall be the same as that used in building up the membrane. Each individual plank shall be crowded tightly against the adjacent plank and the completed work shall have a uniform smooth surface without open cracks or spaces.

(d) Class D Waterproofing.

Waterproofing materials for Class D Waterproofing shall be installed in accordance with the manufacturer's requirements.

No backfilling shall be done without the permission of the Engineer. Backfill shall be placed in such a manner that the waterproofing will not be damaged. No stones, broken concrete, bricks, or other material likely to damage the waterproofing material shall be placed adjacent to waterproofed surfaces.

(e) Dampproofing.

1. Preparation of Surface.

   The provisions of Subarticle (a) above shall govern.

2. Application.

   Surfaces to be dampproofed shall be given one coat of hot primer before the first mop coat. The primer shall be well worked in to give a uniform coating. The priming coat shall be applied approximately 24 hours before applying the first mop coat. The primer shall be dry before this first mop coat is applied.

   After the primer is dry, the first mop coat of asphalt shall be applied hot over the entire surface to be dampproofed and well worked in. After the first mop coat is dry, a second mop coat shall be applied. The amount of material for each mop coat shall be not less than 4.5 gallons per hundred square feet {2 L/m^2} of surface.

   Asphalt shall not be heated above a temperature of 350 ºF {175 ºC}. The material shall be stirred frequently while being heated. Kettles shall be equipped with armored thermometers and oil jackets.

   Backfilling shall be as provided by Subarticle (a) above.

515.04 Method of Measurement.

The quantity of Waterproofing and Dampproofing to be paid for under this Section shall be the actual number of square yards {square meters} of waterproofing of the various types as previously described and dampproofing, respectively, measured in place, completed and accepted.

515.05 Basis of Payment.

(a) Unit Price Coverage.

The quantity of Waterproofing and Dampproofing, measured as provided above, will be paid for at the contract unit price per square yard {square meter} for the particular type of waterproofing specified, which price and payment shall be full compensation for furnishing and placing all materials, including the protection course, and for all equipment, tools, and labor necessary for the satisfactory completion of the work.

(b) Payment will be made under Item No.:

515-A Class ___ Waterproofing - per square yard {square meter}
515-B Dampproofing - per square yard {square meter}

SECTION 517
BRIDGE AND SIDEWALK HANDRAIL

517.01 Description.

This Section shall cover the work of fabricating, furnishing, and installing handrail on structures in accordance with details and at the location shown on the plans, all in conformity with the requirements noted herein or shown on the plans.

517.02 Materials.

Materials used in fabrication and installation shall conform to the applicable Section of the Specifications that the structure to which the railing is to be attached was constructed, the details shown on the plans, and the following:

Galvanized Steel Pipe Handrail. Galvanized steel pipe shall meet the requirements of ASTM A 53, Grade B; this grade of pipe to include rail elements and post.

Steel shapes, plates, and accessories shall be structural or alloy steel galvanized in accordance with AASHTO M 111.

Bolts, nuts, washers, and other fasteners shall be galvanized in accordance with AASHTO M 232, Class C, with nuts tapped after galvanization in accordance with ASTM A 563 {A 563M}.

Galvanized Steel Handrail. Galvanized steel shall be structural or alloy steel, hot dipped galvanized after fabrication in accordance with AASHTO M 111.

Bolts, nuts, washers, and other fasteners shall be galvanized in accordance with AASHTO M 232, Class C, with nuts tapped after galvanization in accordance with ASTM A 563 {A 563M}.

Beam Type Handrail. Beam type handrail shall meet the requirements for beam guardrail as provided in Sections 630 and 864.

Ornamental Handrail shall meet the requirements shown on the plans.

Aluminum or Galvanized Steel Sidewalk Handrail. Material for use in aluminum or galvanized steel sidewalk handrail shall meet the requirements specified on the plans.

Concrete Handrail. Concrete handrail shall be cast-in-place type conforming to the appropriate requirements of Section 501 and the details shown on the plans.

Posts for Beam Type Handrail. Steel posts shall meet the requirements of Sections 836 and 864. Timber posts shall be treated in accordance with Section 833.

517.03 Construction Requirements.

Rail shall be erected in accordance with the best construction practices and in conformity with lines, elevations, and other details indicated on the plans.

The plans will show construction details and will specify the type or alternate types of handrail to be used.

Where the Contractor is permitted to choose the type rail he wishes to use, he shall indicate in the proposal his choice. One type, once selected, shall be used throughout the project.

517.04 Method of Measurement.

The accepted bridge and sidewalk handrail will be measured in linear feet {meters}, to the nearest 0.1 of a foot {0.1 m}, along the axis of the top rail between extreme limits of the handrail without deductions for laps, posts, or joints.

All stair railing, posts, and appurtenances for one stair tower, including pipe railing on the superstructure but not a part of the bridge or sidewalk handrail, installed and accepted complete in place will be measured as one set of stair railing.

No measurement or separate payment will be made for post or miscellaneous hardware required for installation of handrail and stair railing, such being considered incidental to the installation of the rail.

517.05 Basis of Payment.

(a) Unit Price Coverage.

The number of linear feet {meters} of bridge and/or sidewalk handrail and the number of sets of stair tower handrail, measured as provided above, will be paid for at the contract unit prices of the appropriate pay items complete in place, which shall be payment in full for all materials including rail elements, posts, hardware, and paint; for forms; for constructing, bracing, and erecting; and for all equipment, tools, labor and incidentals necessary to complete the items in accordance with plans and specifications.

(b) Payment will be made under Item No.:

517-A __*__ Handrail - per linear foot {meter}
517-B Beam Type Handrail, Type Posts - per linear foot {meter}
517-C Type Railing Stair Railing - per set
517-D Aluminum/Galvanized Steel Sidewalk Handrail - per linear foot {meter}
* Galvanized Steel, Galvanized Steel Pipe, Ornamental, or Cast-In-Place Concrete

SECTION 520
REPAIR OR RAISING EXISTING BRIDGES

520.01 Description.

This Section shall cover the work of furnishing all materials, tools, equipment, labor, falsework, or cribbing and all incidental items necessary to repair members or portions of an existing bridge or change the elevation of an existing bridge as may be required by the detailed plans.

The work shall also include the removal and satisfactory disposal of all waste material, damaged portions replaced, and all falsework and/or temporary bracing, etc.

520.02 Materials.

Since the majority of the work required under this Section is primarily a work item, materials not to be incorporated into the completed structure shall be of such quality as to serve the needs adequately. However, any material which is to become a part of the completed structure shall meet the requirements of Division 800, Materials, for the respective type of member or part involved.

520.03 Construction Requirements.

(a) Repairing of Existing Bridge.

The Contractor shall assemble all materials and equipment required to complete the repairs on any particular member of the bridge and shall adequately strut and brace members which are to be cut to ensure maintaining correct distance between joints and provide temporary load carrying members and supports during such time as members are cut, prior to the cutting of any main member. Prior to beginning work, the Contractor shall submit to the Engineer his plans for bracing main members for approval.

(b) Raising Existing Bridge.

The Contractor shall furnish sufficient equipment of adequate capacity to raise any particular unit of the bridge, or the entire bridge, without injury to same, giving (1) uniform support and bearing at sufficient intervals and (2) adequate falsework, each as approved by the Engineer to support safely the portion of or the entire bridge while being raised until it is set on its new permanent supports. Prior to beginning work the Contractor shall submit to the Engineer (1) his plans for falsework and (2) list of equipment proposed for use. Both of these must be approved before the actual raising operation begins.

When raising of a bridge involves a truss structure, the Contractor may be permitted to remove existing trusses from the bridge piers and store them at an approved storage site, provided a satisfactory method of removal, transporting, and re-installation of the trusses is submitted and approved by the Bridge Engineer. In such event the Contractor shall make all necessary arrangement for and furnishing of any storage area.

NOTE: Storage areas must be approved by the Engineer, and a site will not be considered for approval unless the proposed site is under the direct control of the Contractor and its location is either on the project or in close proximity thereto.

520.04 Method of Measurement.

Each existing bridge to be repaired, raised, or bridge having a portion or portions of same to be repaired or raised will be shown on the plans and in the proposal by its station number, and for the purpose of measurement and payment will be considered a complete and separate unit.

520.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item 520-A.

Payment for repairs to existing bridge shall be made at the contract bid price (lump sum) which shall be payment in full for all material, equipment, tools, labor, falsework, struts, support, and incidentals necessary to complete the work required by this Section and detailed in the plans.

2. Items 520-B AND 520-C.

Payment will be made at the respective contract lump sum prices for items of raising existing bridges or portions of existing bridge at designated stations listed in the contract. The lump sum price shall be payment in full for the furnishing of all equipment, tools, labor, falsework and/or cribbing, storage area, and incidentals necessary to complete the work including the removal and satisfactory disposal of falsework and/or cribbing.

(b) Payment will be made under Item No.:

520-A Repairs to Existing Bridge, Station _____ - per lump sum
520-B Raising Existing Bridge, Station _____ - per lump sum
520-C Raising Portion of Existing Bridge, Station _____ - per lump sum

SECTION 521
STEEL BRIDGE COATING

521.01 Description.

This Section shall cover the work of applying coatings to steel for new construction and to existing bridges in the field for the protection of structural steel portions of bridges.

Special requirements are given for the removal of coatings on existing bridges and for the disposal of the removed coating material.

The requirements for coating are applicable regardless of whether or not payment for the coating is included in the payment for the steel (usually new construction) or is a separate payment for the field application of the coating on an existing bridge.

521.02 Materials.

Coating materials shall conform to the requirements given in Section 855, "Coatings, Paints, Enamels, and Varnishes for Metal and Wood Structures". Requirements for coating are also given in Section 836, "Structural Steel, Fasteners and Miscellaneous Metals".

There are three basic types of coating systems. These systems are:

- System 1, zinc primer with various types (acrylic, epoxy, urethane) of intermediate and top coats;
- System 2, acrylic primer, intermediate and top coats;
- System 3, epoxy mastic.

The required dry film thickness and the required color of each coat are given in Article 855.05.

521.03 Selection of Coating System.

The type of required coating system will be shown on the plans or designated elsewhere in the contract. The coating system proposed for application shall be selected from the list of approved coating components if a proprietary coating system is not shown on the plans.

The Contractor shall submit a written notification of the following:

- the name and address of the supplier of the coating system;
- the product names of each coat proposed for application;
- the supplier number from the list of approved coating systems.

If the coating is proposed for application on existing structures the Contractor shall give this written notification to the Project Manager at least 14 calendar days prior to the beginning of the application of the coating.

If the coating system is proposed for new construction the Contractor shall give this written notice to the Project Manager and forward a copy of the notification to the Bridge Engineer prior to, or with the first submittal of the structural steel shop drawings.

521.04 Blast Cleaning, Mechanical Cleaning and Surface Roughness.

(a) Potential Hazardous Waste from Cleaning Existing Steel Surfaces.

Historically the results of testing performed on existing coatings shows that there is a strong likelihood that the blast waste will be hazardous due to the presence of the heavy metals lead and/or chromium. Existing coatings may be tested, prior to bidding, for potential hazardous materials. The results of this testing, should it be performed, will be provided to potential bidders by plan notes or other supplementary documentation that will be included in the bidding proposal. All cleaning waste (blast waste, mechanical cleaning waste, etc.) shall be handled as hazardous waste until appropriate testing (Toxicity Characteristic Leaching Procedure TCLP, EPA Test Method 1311 test given in the EPA manual SW-846) has been conducted and a determination has been made to the contrary.

The Contractor shall be fully responsible for all expenses that may be due to the handling and disposal of hazardous waste that is generated from cleaning existing steel bridge surfaces.

(b) Blast Cleaning Surface Preparation for Coating Systems 1 and 2.

Unless noted otherwise on the plans, the surfaces that are to be coated with Coating System 1 shall be blast cleaned to conform to the requirements given in Steel Structures Painting Council Specification SSPC-SP 10 "Near-White Blast Cleaning".

Unless noted otherwise on the plans, the surfaces that are to be coated with coating system System 2 shall be blast cleaned to conform to the requirements given in Steel Structures Painting Council Specification SSPC-SP 6 "Commercial Blast Cleaning".

(c) Mechanical Cleaning Surface Preparation for Coating System 3.

Unless noted otherwise on the plans, the surfaces that are to be recoated with Coating System 3 shall be prepared by SSPC-SP 2 “Hand Tool Cleaning” or SSPC-SP 3 “Power Tool Cleaning”, SSPC-SP 12 “Surface Preparation by High- and Ultrahigh-Pressure Water Jetting”, or other means to remove loose paint and loose rust prior to recoating.

(d) Required Surface Roughness after Blast Cleaning.

After blast cleaning, the anchor pattern shall be from 25 μm to 75 μm deep in a dense and uniform pattern of depressions and ridges, as determined by use of a press-o-film type tape and a spring micrometer or equal as approved by the Department, for all coating systems. The press-o-film type tape and a spring micrometer shall be provided by the Contractor.

521.05 Containment System for Removal of Coating from Existing Bridge.

The preparation (blasting and final cleaning) of surfaces for the application of System 1 and System 2 coatings on an existing bridge shall be done in a containment system, unless designated otherwise on the plans. The preparation of surfaces for the application of System 3 coatings will not require a containment system unless designated otherwise on the plans.

The containment system shall consist of vertical (and horizontal if necessary) screening with a collection/recovery area in position at all times that coating removal work is in progress. Screening material shall consist of approved material suitably stiffened by bracing to form an assembly with sufficient strength to withstand winds and adverse weather conditions normally encountered during the season in which the work is performed. The screening shall extend the full vertical distance between bridge steel and collection area. The containment system shall not cause a hazard to the traveling public.

The containment system shall be designed to have air-moving equipment capable of:

- maintaining OSHA acceptable airborne concentrations of hazardous material;
- providing adequate worker visibility;
- preventing any spent material or dust from leaving the enclosure and;
- collecting the material for disposal.

Air quality will be visually monitored by the Engineer. Any dust outside the containment structure shall be justification for suspension of the work.

521.06 Collection and Disposal of Coating Material Waste from Existing Bridge.

Coating material and other debris removed from an existing bridge shall be collected by the Contractor in the containment system. This material shall be stored in approved containers for subsequent transportation to an approved disposal site. The Contractor shall store and dispose of contaminated debris in accordance with the requirements of the ADEM. Any testing required by the ADEM to be performed on the collected waste shall be the responsibility of the Contractor.

The Contractor shall collect representative samples of the waste, as generated, in a storage vessel. A composite sample shall be collected for each 20 cubic yards {15 m^3} generated per bridge site. Adjacent

dual bridges will be considered as one site, unless noted otherwise on the plans. A composite sample shall be made by taking several small samples from random locations in the collected waste. The Contractor shall have the sample tested for hazardous materials using the Toxic Constituents Leaching Procedure (TCLP) as specified in EPA manual SW-846. Test results shall be submitted to the Engineer within 7 days from the date that the results are received by the Contractor.

Waste which exceeds any regulatory threshold for a characteristic waste shall be handled as a hazardous waste. The Contractor shall be responsible for complying with all hazardous waste rules and regulations of the EPA and the ADEM including, but not limited to, such things as generator I.D. numbers, labeling, manifesting, etc. The waste shall not be stored for over 90 days. It must be transported only by a permitted transporter, and must be disposed of in an authorized hazardous waste facility. No treatment shall be conducted at the coating removal site. Any land ban certifications shall be the responsibility of the Contractor. The Contractor, acting on behalf of the Department, is the generator of the waste and shall sign any manifest or similar documents as such. The Contractor shall secure the approval of the Engineer for the transporter and the disposal facility at least five days prior to initiation of a shipment of waste. All personnel involved in the waste generation or handling shall be trained in accordance with EPA/OSHA directives. The Contractor shall reimburse the Department for all costs that may be incurred by the Department due to the failure of the Contractor in complying with all regulatory requirements for the containment, collection, storage and disposal of the blast waste.

Waste which does not exceed the regulatory threshold for a characteristic waste shall be handled as an industrial solid waste. It shall be stored in accordance with the ADEM (Land Division-Solid Waste Branch) directives. Disposal shall be in accordance with the ADEM guidelines at an ADEM approved facility. The Contractor shall secure, in writing, the ADEM authorization for said disposal. The Engineer shall be given a copy of the authorization upon receipt by the Contractor.

If contaminated material is transported to or through another state, work performed in that state shall be in conformance with any applicable regulatory agencies in the state involved.

Copies of all required regulatory documentation, including ADEM Form 8700-12, shall be delivered to the Engineer at the time that they are submitted to the regulatory agencies. The work will not be accepted until all required notifications and permit terminations have been completed and copies of the Receipt of Termination for all permits, including the ADEM Form 8700-12, provided to the Engineer.

521.07 Surface Preparation Plan Submittal for the Removal of Existing Coatings.

Prior to beginning the work of removing coatings from existing bridges, the Contractor shall submit a Surface Preparation Plan for review and distribution by the Construction Engineer. Copies of the plan shall be submitted as Working Drawings in accordance with the requirements given in Section 105. The Contractor will not be required to have the plan stamped and signed by a Licensed Professional Engineer unless the preparation of details shown on the plan (for example temporary structural supports) is addressed in Alabama law regulating the practice of engineering. The plan shall be created to comply with all rules and regulations of EPA, ADEM, OSHA and any other agency that has regulatory authority and shall include:

- the cleaning methods and products proposed for removal of paint with product manufacturer documentation of the effectiveness of the cleaning methods and products in producing non hazardous blast waste;
- a work phase diagram describing how the debris shall be contained while blasting and coating operations are conducted;
- a detailed drawing and/or description of the enclosure listing the type of covering, details of the covering support materials, details of the connections to the bridge structure;
- methods and equipment proposed for collecting the blast debris;
- description of the containers and the location proposed for storing the blast debris;
- drawing at an appropriate scale to show the location of the storage of the blast waste in relation to the location of the work;
- copies of the submittal of ADEM's Form 8700-12. (If TCLP testing of blast waste proves that it is non-hazardous the Contractor may request release from ADEM's Form 8700-12 with approval of the Engineer.);
- description of the details, location and procedures for disposal of the blast debris.

521.08 Final Cleaning of Blast Cleaned Surfaces.

Blast cleaned surfaces shall be cleaned immediately prior to the application of the primer coat. All weld spatter, flux, slag, fume, and other objectionable deposits shall be removed prior to blast cleaning. The area of the welds shall be neutralized with suitable chemicals if this is required for the successful application of the primer. All areas repaired after blasting by welding, grinding or any other method shall be reblasted if deemed necessary by the Engineer.

Before the application of the primer to the blasted surfaces, the surfaces shall be brushed with clean bristle brushes, blown with compressed air or vacuumed to remove all abrasives and other loose material from the surfaces. This cleaning shall also be done to remove abrasive deposits from cracks, crevices, corners, and pockets. Oil and grease shall be removed from blast surfaces by means of a suitable solvent.

Potentially hazardous materials collected from the final cleaning on existing bridges shall be collected for proper regulatory disposal.

521.09 Required Location for Application of Coats.

Unless noted otherwise on the plans, the primer coat for new construction shall be applied in the fabrication shop. All other coats for new and existing construction shall be applied in the field after the installation of the steel has been completed.

521.10 Compliance with Coating Manufacturer's Requirements.

All coats shall be installed in accordance with the manufacturer's instructions and precautions for use.

If requested by the Engineer, the Contractor shall have a representative of the coating manufacturer present at the initial application of the coats. The representative shall remain for a period of time necessary to insure that the coatings are being applied satisfactorily and curing properly.

521.11 Equipment for the Application of the Coatings.

Coats shall be applied by spray. Rollers and brushes may be used only on flat surfaces for stripe coating and small coating repairs as directed by the Engineer. Coats shall be applied uniformly to insure complete coverage and to give the required thickness on all surfaces.

Equipment for spraying shall produce satisfactory results without the use of thinner if the use of a thinner is not allowed by the coating manufacturer. If drift of the spray away from the surface to be coated becomes a problem, the Engineer may require spraying to be suspended until conditions are favorable. Spray equipment shall include traps or separators to remove oil and water from the compressed air. The spray equipment shall be kept clean so that dirt, dried coating material and other foreign materials are not deposited in the coat film.

Subsequent coats shall not be applied over a previously applied coat prior to the time that is specified by the manufacturer for the applied coat to cure or dry.

521.12 Time of Application of Primer Coat after Final Cleaning.

The primer coat shall be applied at the time recommended by the coating manufacturer, if that time is less than 24 hours after final cleaning. The primer coat shall always be applied within 24 hours after final cleaning. Under no circumstances shall the steel be permitted to rust before coating, regardless of the time elapsed. Rust shall be cleaned by blasting or other methods approved by the Engineer.

521.13 Quality Control for Application of Coatings in the Fabricator's Shop.

If requested by the Engineer, the fabricator shall have a representative of the coating manufacture present at the initial application of the coating. The representative shall remain for a period of time necessary to insure that the coatings are being applied satisfactorily and curing properly.

The fabricator shall keep a daily record of each coating operation. The record shall be kept more frequently if the materials or coating operations change during the coating process. The coating records shall be kept on a form furnished by the fabricator that is acceptable to the representative of ALDOT.

Each coating record shall contain the ambient temperature, steel temperature, relative humidity, dewpoint, average anchor profile, coating system number, batch number, time and date blasted, time and date coated and all other information that is pertinent to the application of the coating.

After each required coat of paint has cured, the average coating thickness of each member shall be recorded. The minimum and maximum thickness as specified on the coating manufacturer’s written data

shall be required. The averages shall be taken from three evenly divided sections over the length and on each side of the member under examination. The averaging shall be based on SSPC-PA 2 guidelines.

Each coating record form shall be signed by the fabricator's quality control supervisor. A copy of each coating record form shall be given to the ALDOT representative within five working days that coating work was performed. A copy of the manufacturers' certifications of all batch numbers of the applied coatings shall also be submitted to the ALDOT representative with the coating record forms.

Average anchor profile of blasted steel shall be checked using press-o-film type tape. The actual press-o-film type tape used for the measurement of the anchor profile shall be included with the copy of the coating record. Where materials other than beams and girders have been accumulated during a single shift or production run, the anchor profile of randomly selected members shall be checked.

Coatings shall not be applied until the surface to be coated has been inspected and approved by the fabricator's quality control inspector or coatings shop supervisor after final cleaning. This prior approval also applies to additional coats that may be required.

521.14 Worker Protection.

The Contractor shall comply with all requirements of the Occupational Safety and Health Administration (OSHA) and other applicable regulatory agencies with regard to exposure to hazardous materials in construction.

The Contractor shall be responsible for the training of all workers exposed to hazardous materials. The workers shall be informed of the hazards of exposure to these materials and shall be trained in the precautions to take when performing the work.

The Contractor shall provide respiratory protection and protective clothing to all workers and persons entering an area where there is the possibility of exposure to hazardous materials. Protective clothing and equipment shall be approved by OSHA or other applicable regulatory agencies.

521.15 Ambient Conditions for Surface Preparation and Coating Application.

(a) Ambient Conditions for Surface Preparation.

Final surface preparation shall not be performed on steel surfaces which may come into contact with rain, fog, snow, or dew prior to application of the coating. Final surface preparation operations, specifically meaning the 24 hour period within actual coating of steel surfaces, shall not take place when the steel surface is within 5 °F {3 °C} of the dew point or when the steel surface is below 32 °F {0 °C}. The equipment to check the dew point, humidity, and steel temperature shall be furnished by the Contractor.

Surface preconditioning such as SSPC-SP 7 "Brush-Off Blast Cleaning" is allowable when dew point, steel surface temperatures or other conditions are outside of allowable ranges as long as final surface preparation requirements specifically regarding SSPC-SP6 and SSPC-SP10 are completed within the 24 hour period of coating steel surfaces.

(b) Ambient Conditions for Coating Application.

Coating operations shall take place only when the surrounding air temperature or temperature of the steel is above 40 °F {5 °C} and not expected to drop to or below 32 °F {0 °C} prior to drying of the coating. Coatings shall not be applied to damp or frozen steel surfaces. Coatings shall not be applied when the steel surface is within 5 °F {3 °C} of the dew point or at a relative humidity above 85% unless the conditions of application recommended by the coating manufacturer are different and are allowed by the Engineer. Coatings shall not be applied during rain, snow, or fog conditions or when it is likely that moisture in the form of rain, fog, snow, or dew will contact coated surfaces which have not cured to water resistance.

521.16 Additional Requirements for Applying Primer Coat in the Shop.

(a) Exposed Surfaces.

Unless designated otherwise on the plans or in these specifications, all steel surfaces that will be exposed, with the exception of weathering steel, shall be coated in the shop with a primer coat.

Limited painting of weathering steel is required. Only the exposed, non-contact surfaces of weathering steel within a distance from an open joint or finger tooth joint of 1.5 times the depth of the girder (depth at the bearing) shall be painted unless noted otherwise on the plans.

(b) Contact and Inaccessible Surfaces.

Shop contact (faying) surfaces shall not be coated. Surfaces that are not in contact, but will be inaccessible after assembly or erection, shall be coated with all required coats before assembly or erection except for bolted field splice surfaces.

All areas required to be painted that are not readily accessible to spray painting operations shall have primer applied by other means. These areas include, but shall not be limited to, all holes in fabricated items and all clips of stiffeners or gusset plates.

All seams of fabricated items that will not be sealed by welding shall receive a brush applied stripe coat of inorganic zinc prior to the application of the primer coat. The inorganic zinc coating shall be the same as that used for the primer coat. Additional touch up of the stripe coat will be required, if necessary, before final approval is given to the primer coat.

(c) Machined Surfaces and Surfaces at future Field Welds.

Primer coats shall not be applied in the shop to machined surface finishes noted in Article 836.50.

(d) Surfaces of Expansion Dams.

All surfaces of expansion dams shall be coated with primer to the maximum thickness recommended by the coating manufacturer.

(e) Coating with Inorganic Zinc Primer.

When an inorganic zinc primer coat is required, the area of the girder (web and flange), the splice plates, filler plates, gusset plates for all diaphragms, crossframes and lateral bracing, top of the top flange of steel members supporting concrete slabs, and the edges of the top flange shall be coated with the inorganic zinc primer in the shop. The zinc primer shall have been tested for the determination of the slip coefficient as described in Article 855.03.

When an inorganic zinc primer coat is required, the intermediate coat shall not be applied until the primer coat has cured. The Contractor shall ensure that this does not occur by testing the primer coat curing by means of a method recommended by the coating manufacturer.

All overspray, loose or foreign, that would inhibit successful bonding of a subsequent topcoat shall be removed by a method approved by the manufacturer of the product.

(f) Protection of the Primer Coat in the Shop.

The freshly coated steel shall not be handled or moved, except when unavoidable, until the primer coat is dry. All handling shall be performed using methods that will prevent the primer coat from being damaged. Storing shall be done in such a manner that the coating will not be removed or covered with dust, dirt, or other foreign material. In the case that debris does settle and harden on the coated surfaces during periods of extended shop storage, power washing shall be required before materials are staged for delivery. Any surfaces which require cleaning shall be restored to the original acceptable conditions prior to delivery to the project site.

Loading, supporting and securing the steel for shipping shall be done in a manner to prevent damage the primer coating during loading and shipping. Nylon tie-downs, or other materials that will not damage the coating shall be used to secure the steel members during shipment.

(g) Erection Marks.

Erection marks corresponding to those of the erection diagram submitted by the Contractor shall be plainly marked on primer coated surfaces.

521.17 Requirements for Applying Additional Coats over a Shop Primer Coat.

(a) Cleaning Surfaces after Erection.

All debris shall be cleaned from the primed and bare surfaces before the application of additional coats. The Contractor shall use cleaning methods and materials that will not damage the primer coat. Oil and grease shall be removed by the use of a suitable solvent. Care shall be taken not to damage an underlying coat; however, if damage occurs, the underlying coat or coats shall be immediately repaired. On welded work all slag, flux, and spatter shall be removed prior to coating.

(b) Coating Surfaces After Erection.

Immediately after the erection of materials (all connections complete), all bolted connections such as girder connection plates, diaphragm connection plates, field splice plates, galvanized bolts, nuts, washers, and other portions of the structure (except portions in contact with the concrete) which have received a shop applied primer coat and all completed bolt assembly installations shall be cleaned.

All surfaces that have been scraped, chipped, or damaged during shipping and erection and all surfaces of the prime coat that have deteriorated shall be coated as per the coating manufacturers recommendations to restore the prime coat to an acceptable condition prior to top coating operations.

All surfaces that have been scraped, chipped, or damaged during shipping and erection and all surfaces of the prime coat that have deteriorated shall be coated to restore the prime coat.

The coating of structural steel bridge superstructure with a concrete deck shall not be done until after the construction of the deck has been completed. All concrete spills and splashes shall be washed from the structural steel prior to the mortar taking a set.

A succeeding coat shall not be applied until the previous coat has dried throughout the full thickness of the coating film.

The coatings shall be protected from discoloration and disfigurement by dust, insects, and other causes until dry. The Contractor shall protect pedestrian, vehicular, and other traffic that moves on or underneath the bridge from damage and disfigurement by errant spray and other coating operations. The Contractor shall protect all uncoated surfaces of the bridge from damage and disfigurement.

If traffic produces an objectionable amount of dust and dirt, the Contractor shall, without extra compensation, take means to prevent the dust and dirt from coming in contact with the surfaces that are being cleaned and are being coated. It shall be the Contractor's responsibility to protect all property, public and private, from damage that may result from the cleaning and coating operations.

521.18 Additional Requirements for Coating Surfaces on an Existing Bridge.

Steel and other metals shall consist of the metals of the substructure and superstructure structural steel areas and contiguous metal surfaces, and such surfaces as galvanized pipe, conduits and junction boxes, metal ladders, gratings, railings, platforms, operator's houses (metal or other material), navigation light stands, guyed masts, supporting overhead cable (excluding public utility masts, cable brackets and appurtenances), traffic gate housing, metal drains on steel spans, and surfaces of all machinery housing and parts that do not require lubrication. Any cleaning that is deemed by the Engineer to be harmful to the metal shall be discontinued.

A succeeding coat shall not be applied until the previous coat has dried throughout the full thickness of the coating film.

The coatings shall be protected from discoloration and disfigurement by dust, insects, and other causes until dry. The Contractor shall protect pedestrian, vehicular, and other traffic that moves on or underneath the bridge from damage and disfigurement by errant spray and other coating operations. The Contractor shall protect all uncoated surfaces of the bridge from damage and disfigurement.

If traffic produces an objectionable amount of dust and dirt, the Contractor shall, without extra compensation, take means to prevent the dust and dirt from coming in contact with the surfaces that are being cleaned and are being coated. It shall be the Contractor's responsibility to protect all property, public and private, from damage that may result from the cleaning and coating operations.

521.19 Method of Measurement.

The completed and accepted work shall be measured in lump sum units, each identified by station number or mile {kilometer} post number in the proposal. The quantities of surface area that may be shown on the Plans are approximate estimates of the surface area that will be required to be coated. The Contractor shall determine the actual amount of surface area that is required to be coated and base the bid on this actual amount.

521.20 Basis of Payment.

(a) Unit Price Coverage.

Separate payment for applying a coating to a new bridge will be made only when the proposal includes a pay item for this work. Otherwise, payment for this work shall be included in Items 508-A, 508-B, 508-E, or 508-F, whichever is appropriate.

Items 521-A and 521-B, measured as provided above, will be paid at the contract lump sum prices for the specified units. These prices shall be full compensation for all shop or field cleaning of metal, for containing, collecting, storing, testing, transporting and disposing of cleaning debris, for furnishing abrasives and cleaning solvents, for furnishing a surface profile comparator, for furnishing and applying the coating material, for supplying safety equipment and clothing, and for all materials, equipment, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

521-A Coating New Bridge at _____ - per lump sum

521-B Coating Existing Bridge at _____ - per lump sum

SECTION 522
BRIDGE JOINT SEALS

522.01 Description.

This Section shall cover the work of furnishing and installing bridge joint seals at the locations shown by the plans or directed, all in accordance with this specification and plan details. Said seals are for the purpose of preventing the passage of water and other materials through the joint.

Types of bridge joint seals have been classified as follows: Compression Seals and Diaphragm Type Seals.

522.02 Materials.

Materials furnished for use under this Section shall conform to the appropriate requirements of Division 800, Materials, and the plan details.

Bridge joint seals for existing bridges shall be the type of seal material shown on the plans.

522.03 Construction Requirements.

(a) General.

The sealing of bridge joints shall be limited to those joints noted by the plans to be sealed.

The plans and proposal will designate the "total joint movement" for which a joint is to function. Shop drawings of the bridge joint seal system designated by the plans or, if allowed, selected by the Contractor from the plan designated alternates, must be approved by the Bridge Engineer.

Shop drawings, etc. of the seal system shall be submitted to the Bridge Engineer for approval. After final approval of the drawings, the Contractor shall resubmit seven copies of the drawings plus one set of satisfactory reproducibles (Mylar or equal) for distribution.

(b) Forming of Joint.

Special attention shall be given to joint construction to insure that proper allowances for temperature, skew, etc. are made in forming the joint width. In the same manner, the anchorage system (bolts, plates, etc.) or joint armor shall be carefully set in the formwork to insure proper anchorage and functionability of the completed joint. All elements of the joint seal system shall be on hand before commencing forming of the joint.

(c) Installation of Bridge Interior Joints.

It shall be the Contractor's responsibility to insure that the joint width, alignment, etc. is in accordance with the bridge plan details and approved shop drawing. Any deviation from the plans and approved shop drawings shall be reported and corrective remedial action taken before installing the seal element.

Installation of the seal element shall be in accordance with the manufacturer's recommendation and Departmental directives. Care shall be taken to insure the proper cleaning of the joint and use of lubricants, adhesives, or combination lubricant-adhesive during the installation. Splicing of the seal elements will not be permitted in a joint system unless so noted by plan details or the approved shop drawings.

(d) Installation of Bridge End Joints.

The Bridge Contractor shall install that portion of the bridge end joint anchorage system required to be installed in the bridge deck in accordance with bridge plan details and approved shop drawings. The remaining elements shall be match-marked and properly stored as directed until such time as the bridge end slab is constructed or the contract is terminated, at which time the stored elements shall be turned over to the Engineer.

The Contractor constructing the bridge end slab shall have the responsibility of incorporating that portion of the joint seal system required by the bridge plans and approved shop drawings into the bridge end slab. It shall be the Contractor's responsibility to insure that the joint width, alignment, etc. is in accordance with above noted requirements; any deviation shall be reported and corrective remedial action taken before installing the seal element. The portion of the joint seal system to be installed in the bridge end slab and the seal element will be made available to the bridge end slab Contractor along with installation details if such is not provided by the plan details. The Contractor shall have full responsibility for protection, etc. of elements of the joint seal system furnished him until the joint seal system is accepted. Any damage to the elements caused by his operations shall be corrected as directed

without additional compensation. Installation of the seal element shall be as noted in the second paragraph of Subarticle 522.03(c).

(e) Bridge Joint Seal.

The Contractor shall obtain the manufacturer's recommendations for the installation of the joint seals and shall furnish these recommendations to the Engineer prior to the installation of the seals. The seals shall be installed as directed by the Engineer.

522.04 Method of Measurement.

(a) Items 522-A, 522-B, and 522-C.

Ordered and accepted sealed joints will be measured in linear feet {meters} along the top surface of the designated joint between the bridge gutters to the nearest 0.1 foot {millimeter}. No measurement will be made for that portion of the seal required by plan details to extend through or above the gutter line; such being considered incidental to the sealing of the joint.

(b) Items 522-D and 522-E.

These items, when provided, will be measured as a lump sum unit for the designated bridge structure. Said measurement will cover the sealing of all the bridge joints of the type designated, interior or end, all in accordance with the plan requirements and the details noted in this Section.

(c) Item 522-G.

The joint seal will be measured in linear feet {meters} along the top of the installed and accepted seal.

522.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item 522-A.

The accepted sealed bridge joints, measured as noted above, will be paid for at the contract unit price bid for each designated joint width, which shall be full compensation for the fabrication and furnishing of all materials necessary to provide a complete functional sealed joint (armor plates, anchor bolts, extrusions, channels, seal elements, etc.), for the incorporation and installation of all elements into the structure, and for all equipment, tools, labor, and incidentals necessary to provide a complete operational sealed joint.

2. Item 522-B.

The accepted bridge end joint seal system, measured as noted above, will be paid for at the contract unit price bid for each designated joint width, which shall be full compensation for the fabrication and furnishing of all materials necessary to provide a complete, functional sealed joint (armor plate, anchor bolts, extrusions, channels, seal element, etc., except the lubricant-adhesive used to install the seal element), for the partial installation of that portion of the seal system required to be installed in the bridge decks, and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

3. Item 522-C.

The accepted partial installation of the bridge end joint seal system, measured in the same manner as noted for a complete sealed system, will be paid for at the contract unit price bid which shall be full compensation for incorporation of that portion of the bridge end joint seal system required to be installed into the bridge end slab and the installation of the seal element (all components of the seal system, except the lubricant-adhesive used to install the seal element), for the lubricant-adhesive, and for all equipment, tools, labor, and incidentals necessary to provide a completely operational joint system.

4. Item 522-D.

The accepted sealed bridge, measured as noted, will be paid for at the contract lump sum price bid which shall be full compensation for the fabrication and furnishing of all materials necessary to provide completely functional joint seal systems (armor plates, anchor bolts, extrusions, channels, seal elements, etc.) for the structure, for the incorporation and installation of all elements into the structure, and for all equipment, tools, labor, and incidentals necessary to provide the structure with complete, functional joints.

5. Item 522-E.

The accepted bridge end joint seal systems, measured as noted above, will be paid for at the contract lump sum price bid which shall be full compensation for the fabrication and furnishing of all

materials necessary to provide the completely functional bridge end joints systems (armor plates, anchor bolts, extrusions, channels, seal elements, etc., except the lubricant-adhesive used to install the seal element) for the structure, for the partial installation of the seal systems (that portion of the seal systems required to be installed in the bridge decks), and for all equipment, tools, labor, and incidentals necessary to complete this item of work.

6. Item 522-G.

The accepted bridge joint seal, measured as noted above, will be paid for at the contract price bid per linear foot which shall be full compensation materials, equipment, tools, labor and incidentals necessary to furnish and install the seals.

(b) Payment will be made under Item No.:

522-A Furnishing and Installing Bridge (Interior or End) Joint Seal System ___ inch {mm} Total Joint Movement - per linear foot {meter}

522-B Furnishing and Partial Installation of Bridge End Joint Seal System ___ inch {mm} Total Joint Movement - per linear foot {meter}

522-C Partial Installation of Bridge End Joint Seal System - per linear foot {meter}

522-D Furnishing and Installing Bridge (Interior or End) Joint Seal Systems, Station _____ - per lump sum

522-E Furnishing and Partial Installation of Bridge End Joint Seal Systems, Station _____ - per lump sum

522-G Bridge Joint Seal - per linear foot {meter}

SECTION 524
REINFORCED CONCRETE BOX CULVERTS

524.01 Description.

This Section shall cover the work of constructing reinforced concrete box culverts in accordance with the details shown on the plans. The Contractor shall have the option of constructing either cast-in-place or precast concrete culverts if the required type of culvert is not shown on the plans.

524.02 Materials.

(a) Applicable Sections.

The requirements given in the following Sections shall be applicable (unless modified by the requirements given in this Section) to the construction of box culverts.

Section 214, Structure Excavation and Backfill for Drainage Structures and Minor Structures
Section 501, Structural Portland Cement Concrete
Section 502, Steel Reinforcement
Section 831, Precast Concrete Products

(b) Concrete for Culverts Cast in Place.

Concrete for cast in place culverts shall be Class B concrete.

(c) Joint Sealers for Precast Concrete Culverts.

Joint sealer shall be one of the types meeting the requirements given in Article 846.01, unless shown otherwise on the plans.

524.03 Construction Requirements.

(a) Excavation, Backfilling and Water Quality Protection.

1. Excavation and Backfilling.

Excavation and backfilling shall be in accordance with the requirements given in Section 214. In addition to the requirements given in Section 214, precast concrete culverts shall be placed on a bedding layer of backfill. The requirement for a bedding layer will be met if extra depth excavation and backfill is required. If extra depth excavation and backfill is not required, the bedding layer shall be a minimum compacted thickness of 4 inches {100 mm} of foundation backfill placed at least 2 feet {600 mm} wider than the extent of the outside walls (1 foot {300 mm} on each side of the culvert).

2. Water Quality Protection.

The Contractor shall be fully responsible for protecting the quality of the water at the site of the culvert by preventing erosion and by capturing and removing sediment at diversion channels and cofferdams. Unless otherwise shown on the plans, provisions for water quality protection at the culvert site shall be designed and implemented by the Contractor. Details of these provisions shall be included in the Stormwater Management Plan.

(b) Type of Required Culvert.

The type (either cast in place or precast) of required culvert may be shown in the pay item descriptions for the culvert construction. The Contractor shall construct that type of culvert if the type designation is shown. The Contractor shall have the option of constructing either cast-in-place or precast concrete culverts if the required type of culvert is not shown in the pay item description.

(c) Preparation for Culvert Extension.

The extension of a culvert shall include the cutting or breaking away of portions of the existing culvert and the preparation of the exposed structural material for joining with the new culvert materials.

(d) Culverts Constructed with Cast in Place Concrete.

1. Sequence of Concrete Placement for Slabs and Walls.

Concrete for the bottom slab shall be placed and allowed to set before the placement of concrete for the walls and top slab.

The walls and top slab in culverts that have an overall height of 8 feet {2400 mm} or less may be constructed with a continuous placement of concrete. The walls and top slab in culverts that have an overall height greater than 8 feet {2400 mm} shall be constructed by separate placements of concrete.

When the walls and top slab are constructed by separate placements of concrete, the concrete in the walls shall be strong enough to allow the placement of the concrete without damage to the walls.

2. Preparation of Construction Joints.

All construction joints shall be thoroughly cleaned of all debris. The concrete surface shall be carefully chipped and roughened in accordance with the method of bonding construction joints given in Section 501.

3. Required Construction Joints.

Construction joints shall be provided on all culverts over 60 feet {18 m} in length with the spacing of the joints set to provide approximately equal length sections along the culvert. One construction joint will be required for culvert lengths between 60 feet {18 m} and 90 feet {27 m}. Two construction joints will be required for culvert lengths greater than 90 feet {27 m} and less than 135 feet {41 m}. Three construction joints will be required for culverts from 136 feet {41 m} to 170 feet {52 m} in length. For culverts over 170 feet {52 m} in length, construction joints shall be spaced at approximately equal intervals of not less than 40 feet {12 m} nor more than 55 feet {17 m}.

All required construction joints shall be constructed normal to the center line of the culvert.

4. Tolerances.

The height and width of the openings shall not vary by more than 1 % from the plan dimensions. The slabs and walls shall not be thinner than the plan dimensions, but may be thicker by 5 % more than the plan dimensions.

The interior surfaces shall not vary by more than 1/4 of an inch {6 mm} from a 10 foot {3 m} straightedge placed anywhere on any interior surface.

The clearance of the reinforcing steel shall not be less than the plan clearance and shall not be greater than 3/8 of an inch {9 mm} more than the required plan clearance.

(e) Culverts Constructed with Precast Concrete Units.

1. Standard Details for Precast Concrete Culverts.

For culverts with more than 2 feet {600 mm} of cover the precast units shall be manufactured in accordance with the details given in AASHTO M 259 {M 259M} "Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers".

For culverts with less than 2 feet {600 mm} of cover the precast units shall be manufactured in accordance with the details given in AASHTO M 273 {M 273M} "Precast Reinforced Concrete Box

Sections for Culverts, Storm Drains, and Sewers with Less Than 2 feet {600 mm} of Cover Subjected to Highway Loading".

Each precast unit shall be a one piece design cast as a monolithic unit.

2. Submittal of Details.

Details and design calculations, sealed by a Licensed Professional Engineer, shall be submitted as Shop Drawings in accordance with all of the requirements given in Article 105.02 when the conditions of loading differ from what is given in ASTM C 1577. Details and design drawings shall be submitted as Working Drawings for all pipe entrances, connections to drainage structures, bends in culvert alignment, wingwalls, aprons and guardrail attachment.

3. Transition for Extending Culverts.

A uniform transition shall be constructed where new or existing cast in place culverts are extended with precast units. A doweled or tongue and groove connection shall be provided at the junction of the precast unit and the cast in place section. Details and design calculations for the transition shall be submitted in accordance with the requirements given in Article 105.02 for the submittal of Working Drawings.

4. Installation and Connection of Precast Units.

Precast units shall be laid to the same line and grade requirements noted in Item 530.03(a)2. for pipe.

The units shall be connected so that there are no gaps between the ends of the units and the inner surfaces are flush and even.

Sealant shall be applied to the mating surfaces of each unit. The method of sealing the joints shall be the method given for concrete pipe in Subitem 530.03(d)3a. Unless shown otherwise on the plans, the Contractor shall have the option to use any of the type joint sealers given for rigid pipe in Article 846.01.

5. Backfill.

Precast units shall be backfilled in accordance with the requirements given for pipe in Subarticle 530.03(e).

6. End Sections for Precast Concrete Culvert Units.

End sections for precast units, if required, shall be constructed in accordance with the details shown on the plans.

524.04 Method of Measurement.

Payment for reinforced concrete box culverts will be based on units of cubic yards {cubic meters} of Culvert Concrete and pounds {kilograms} of Steel Reinforcement.

The quantity of concrete and reinforcing steel for both cast in place and precast concrete culverts shall be based on the height and width of the openings, the number of barrels, the length of the culvert, and the quantity of concrete and reinforcing steel per unit length of the culvert shown on the plans for the construction of cast in place culverts.

The quantity of concrete and reinforcing steel shown for precast culverts will always be the quantity required for the construction of a cast in place culvert with the same height and width of openings, number of barrels and length.

Wingwalls, parapets, toewalls, and apron quantities shall also always be based on the quantities given on the plans for cast in place construction regardless of a requirement for the installation of precast units.

No additional payment will be made where barrel lengths, apron areas, backfilling, or items of work have to be increased due to the Contractor selecting the option to furnish and install precast units.

Fill concrete required between barrels of precast units will not be measured or paid for separately.

Steel Reinforcement will be measured and paid for under Section 502.

Excavation and Backfill will be measured and paid for under Section 214 with the limitation that payment for foundation backfill for a bedding layer for precast concrete culverts will only be made for a thickness of 4 inches {100 mm} and a width of 2 feet {600 mm} wider than the extent of the outside walls.

Separate payment will not be made for any other items of work involved.

524.05 Basis of Payment.

(a) Unit Price Coverage.

The contract price for Culvert Concrete and Culvert Concrete Extension shall be full compensation for all labor, tools, equipment, and incidentals necessary to construct the complete culvert and related structures (toe walls, wing walls, parapets, connections to drainage structures, etc.). The contract price shall also be full compensation for design and submittals, construction of cofferdams, temporary diversion channels, protection of water quality at cofferdams and diversion channels, flood protection and falsework and formwork. Payment will not be separated for individual culverts.

(b) Payment will be made under Item No.:

524-A Culvert Concrete (_*_) - per cubic yard {cubic meter}
524-B Culvert Concrete Extension (_*_) - per cubic yard {cubic meter}
* Enter either Cast In Place or Precast if the type of construction must be designated.

SECTION 529
RETAINING WALL

529.01 Description.

Retaining walls shall be constructed at the locations and within the limits shown on the plans. Standard details may be shown on the plans for the construction of cast-in-place reinforced concrete retaining walls. The details for the construction of other types of retaining walls may also be shown on the plans.

The submittal and approval of the design and details of a retaining wall is required if the details of the retaining wall are not shown on the plans.

529.02 Materials.

(a) Selected Backfill Material.

Selected backfill material for Mechanically Stabilized Earth (MSE) Walls and Gravity Walls shall be well graded, angular, commercially produced sand or crushed stone (material containing slag will not be allowed) free from organic matter and/or other deleterious material.

The following types of materials will be allowed:

- Concrete sand meeting the requirements of Section 802, Fine Aggregates (F.M. waived).
- Section 801 Coarse Aggregate crushed material that is smaller than #467 with 10% or less passing the #200 {75 µm} sieve.
- Crusher run material with 100% passing a 2-inch {50 mm} sieve and with 10% or less passing the #200 {75 µm} sieve.

(b) Cast-in-Place Reinforced Concrete Retaining Wall.

Concrete for cast-in-place reinforced concrete retaining walls shall be Class A concrete in accordance with the material requirements given in Section 501.

Reinforcing steel shall be furnished and placed in accordance with the material requirements given in Section 502.

The bituminous expansion joint filler and waterstop shall meet the requirements given in Section 832.

Dowels at expansion joints shall be plain Grade 60 bars meeting the requirements given in AASHTO M 31. Pipe sleeves at expansion joints shall be Grade 36 sleeves meeting the requirements given in AASHTO M 270.

Cast-in-place walls shall have a deposit (belt), not less than 1 foot {300 mm} wide and 1 foot {300 mm} deep, of approved local or commercial free draining material placed full length along the back face of the vertical walls at the line of weepholes. This material shall conform to the requirements given in Subarticle 214.02(b).

(c) Mechanically Stabilized Earth Retaining Wall.

Approved ALDOT MSE wall systems are shown in the "Material, Sources and Devices with Special Acceptance Requirements" manual, List II-22, "MSE Wall Systems". The materials required for a mechanically stabilized earth retaining wall shall meet the requirements of the approved MSE wall system. The material and construction requirements shall be shown on the details of the wall submitted

by the Contractor. The details of the wall will be distributed by the Engineer for inspection of the installation of the wall.

(d) Gravity Wall.

Approved ALDOT gravity wall systems are shown in the "Material, Sources and Devices with Special Acceptance Requirements" manual, List II-28, "Gravity Wall Systems". The materials required for a gravity wall shall meet the requirements of the approved gravity wall system. The material and construction requirements shall be shown on the details of the wall submitted by the Contractor. The details of the wall will be distributed by the Engineer for inspection of the installation of the wall.

(e) Precast Concrete Wall Components and Masonry Wall Facing Elements.

All precast and masonry concrete items shall meet the requirements given in Section 831. All precast and masonry concrete items shall meet the material requirements established by the ALDOT through the submittal and approval of wall designs, material requirements and details.

529.03 Construction Requirements.

(a) Contractor's Option to Select the Type of Retaining Wall.

The Contractor shall have the following four options for the construction of a retaining wall if the required type of wall is not shown on the plans:

- ALDOT designed cast-in-place reinforced concrete retaining wall;
- Contractor designed cast-in-place reinforced concrete retaining wall;
- reinforced mechanically stabilized earth (MSE) retaining wall;
- gravity wall.

MSE and gravity walls shall be designed and fabricated by, or under the technical supervision of an ALDOT approved supplier. Approved ALDOT MSE walls systems are shown in the "Material, Sources and Devices with Special Acceptance Requirements" manual, List II-22, “MSE Wall Systems”. Approved ALDOT gravity walls systems are shown in List II-28, "Gravity Wall Systems". Information concerning these lists is given in Subarticle 106.01(f) and ALDOT-355.

(b) Contractor Qualifications.

The Contractor shall submit descriptions of the retaining wall projects completed in the last three years to serve as evidence of the capability to construct the chosen wall system. The descriptions of the retaining wall projects shall contain names and telephone numbers of owners’ representatives who can verify the Contractor’s participation on those projects. These descriptions shall be submitted with the "wall installation plan" and will be evaluated by the Engineer.

(c) Requirement for the submittal of Retaining Wall Designs, Details, and Installation Plan.

The submittal of the design and details of a retaining wall is required if the details of the retaining wall are not shown on the plans. The Contractor shall submit 8 copies of the complete details, material requirements and design calculations to the Engineer for review no later than 30 calendar days after the date of the Notice to Proceed.

The contractor shall also submit a Wall Installation Plan that includes:

- name and experience record of the superintendent in charge of the retaining wall installation;
- list of proposed equipment to be used;
- details of the proposed sequence of retaining wall construction;
- details of planned excavation and shoring methods, if shoring is required;
- details of earth reinforcement placement including methods proposed to prevent damage to the reinforcement during subsequent backfill placement.

The design calculations shall include an analysis of the internal and external stability of the wall and all structural connection details of the wall. All proposed details, material requirements and design calculations shall be stamped and signed by a Licensed Professional Engineer licensed in the state of Alabama and not employed by ALDOT. The design shall be in conformance with the requirements given in the current AASHTO Standard Specifications for Highway Bridges as amended by interim revisions.

The Engineer will review the retaining wall installation plan, wall design details, materials requirements, and design calculations for conformance with the plans and specifications. The Engineer will not approve the submittal but will review it to make sure that it is sufficiently complete to allow the construction of the wall.

The Engineer will return the submittal for corrections, distribute the submittal for construction inspection, or contact the Contractor to establish a mutually agreeable date and time for a meeting to

discuss the submittal. The Contractor will be notified of changes in the submittal deemed necessary within seven days after the meeting. Retaining wall construction shall not begin until the submittal has been distributed for construction inspection and the Engineer informs the Contractor in writing that the proposed wall details, material requirements, design calculations and wall installation plan are complete. Distribution of the submittal for construction inspection shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed on the plans and in the specifications.

Any proposed modification of the installation plan during construction shall be submitted to the Construction Engineer for review and distribution.

(d) Excavation.

The Contractor shall perform the excavation in a manner that will prevent damage to adjacent structures and maintain the stability of the ground adjacent to the excavation.

Excavated material that remains after the construction of the wall shall be used in the formation of the embankment, roadbed, base layers, shoulders, slopes, bedding, backfill for culverts, and for other purposes as allowed or directed by the Engineer. The material shall be suitable for the use that is allowed or directed by the Engineer. Excavated material that cannot be used as a part of the construction in other areas of the project shall be disposed of in accordance with the requirements given in Section 210 for the disposal of surplus material.

(e) Cast-in-Place Reinforced Concrete Retaining Wall.

ALDOT designed Cast-In-Place Walls shall be constructed in accordance with the details shown on Sheets 1 through 4, in ALDOT Standard Drawing RW 10-4.

Concrete for cast-in-place reinforced concrete retaining walls shall be furnished and placed in accordance with the requirements given in Section 501. Reinforcing steel shall be furnished and placed in accordance with the material and construction requirements given in Section 502. All other materials shall be installed in accordance with the details shown on the standard wall details or the approved wall details.

(f) Mechanically Stabilized Earth (MSE) Retaining Wall.

The Contractor shall construct the mechanically stabilized earth (MSE) retaining wall in accordance with the details shown on the Contractor's submittal of the MSE wall that is distributed by the Engineer.

(g) Gravity Wall.

The Contractor shall construct the gravity wall in accordance with the details shown on the Contractor's submittal of the gravity wall that is distributed by the Engineer.

(h) Drainage Layer.

A drainage layer of backfill is required where there are weepholes. The drainage layer shall be free draining material placed full length along the back face of the walls at the line of weepholes. The drainage layer shall not be less than 1 foot {300 mm} wide and 1 foot {300 mm} deep.

(i) Final Finish on the face of MSE and Gravity Walls.

Unless shown otherwise on the plans, MSE and gravity walls shall be built using the concrete finish provided by the manufacturer.

529.04 Method of Measurement.

Compensation for retaining walls will be made for the number of square feet {square meters} within the limits of payment shown on the plans. (The Engineer will not conduct field measurements of the wall for the purposes of payment, other than for Partial Payments under Article 109.07.) The limits of payment will be the following:

- top of the wall;
- bottom of the wall (bottom of leveling pad or footing where the bearing capacity is shown);
- beginning and end of the wall.

The limits for payment shown on the plans will not be altered unless directed by the Engineer in writing. All portions of the wall, except barrier rails, constructed outside the limits for payment shown on the plans will be considered integral and subsidiary to the construction of the wall and will not be measured for payment. Reinforced concrete barrier rails at the top of the wall will be measured and paid for under other items of work.

All other items of work, including but not limited to selected backfill material for all components of the wall, the furnishing and installation/construction of all footings/leveling pads, copings, caps,

reinforcing strips, reinforcing mesh, permanent and temporary facing shall be included in the contract price for the retaining wall and will not be measured separately for payment.

The cost of all excavation within 4 feet {1.3 m} of the front face (top of wall to bottom of footing) of the wall and all excavation behind the wall shall be included in the square foot contract price for the wall. Separate payment will not be made for the use or disposal of the excavated material that remains after the completion of the construction of the wall.

Excavation beyond 4 feet {1.3 m} from the front face of the wall that is required for roadway construction will be paid for under other items of work.

529.05 Basis of Payment.

(a) Unit Price Coverage.

The retaining wall will be paid for at the contract unit price per square foot {square meter} which shall be full compensation for all required designs and submittals and for furnishing all materials, fabrication, erection, construction, excavation, utilization and disposal of surplus excavated material, furnishing and placing selected backfill material, equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

529-A Retaining Wall __*__ - per square foot {square meter}

* Retaining Wall Identification and Supplemental Description, if required. (i.e. Number 1, Number 2, MSE Wall Number 3, etc.)

SECTION 530
ROADWAY PIPE CULVERTS

530.01 Description.

This Section shall cover the work of furnishing and installing pipe type culverts of the size, shape, wall thickness, type material, and appropriate strength designated on the plans or in the proposal. The installation shall be at the locations shown on the plans or designated in conformity with the lines and grades shown by the plans or designated by the Engineer. The work shall include the furnishing and construction of such joints, cuttings, and connections to other pipes or structures as may be necessary to complete the work as shown on the plans or directed.

This Section shall also cover the work of furnishing and installing pipe culverts by the jacking (boring) method of construction. Unless specifically authorized in writing by the Engineer, jacking (boring) shall be used only at the locations shown on the plans. This type of pipe installation will be paid for under Pay Item 530-C.

The following abbreviations will be used:

Concrete Pipe	P.C. for plain concrete R.C. for reinforced concrete
Corrugated Metal	C.M. for any acceptable corrugated metal pipe covered by these specifications
Protective Coating	C. for any protective coating of metal pipe allowed by these specifications
Paved Invert	P.I.
Corrugated Steel	C.S. for Plain Corrugated Steel C.C.S. for Coated Corrugated Steel C.C.S.P.I. for Coated C.S. Paved Invert
Corrugated Aluminum	C.A. for Plain Corrugated Aluminum C.C.A. for Coated C.A. C.C.A.P.I. for Coated C.A. Paved Invert
Concrete Lined	C.L.

Unless a specific type of pipe is designated by the plans or proposal, the Contractor may use one of the optional types of pipe shown by the plans or proposal. However, an installation, once started, shall be made with the same type of pipe throughout unless specifically designated otherwise by plan details, or directed in writing. The Contractor, at his option, may furnish a stronger grade pipe than specified provided no additional cost is incurred by the State for such installation.

The Contractor shall also have the option to use Horizontal Elliptical (H.E.) Pipe in lieu of Concrete Arch Pipe provided the H.E. pipe equals or exceeds the Arch pipe in strength and equivalent opening. If

the Contractor elects to use H.E. pipe, he shall still be paid under the Pay Item for which the H.E. pipe replaces.

530.02 Materials.

Materials furnished for use shall conform to the appropriate provisions of Division 800, Materials, with specific reference made to Sections 831 and 854 and the following:

Section 846 - Pipe Culvert Joint Sealers
Section 850 - Roadway Pipe

If H.E. pipe is used as outlined in Article 530.01, the pipe shall meet the requirements of AASHTO M 207 {M 207M}. The test reports shall also state the size and class of Arch pipe for which the H.E. pipe is substituted.

Concrete pipes furnished for jacking (boring) shall be smooth pipes without bells.

Unless shown otherwise on the plans, smooth steel pipe furnished for jacking (boring) shall be manufactured from steel having a minimum yield strength of 36,000 psi {250 MPa}. The pipe shall be fabricated in sections for welded field joints. The Contractor shall select the wall thickness of the pipe consistent with his operation; however, the minimum wall thicknesses shall be as follows:

30 inch {750 mm} and smaller diameter	3/8 inch {9.5 mm}
36 inch to 42 inch {900 mm to 1050 mm} diameter	1/2 inch {12.7 mm}
48 inch {1200 mm} and larger diameter	5/8 inch {15.8 mm}

The pipe shall be coated inside and outside with at least one shop coat of an approved primer paint and one shop coat of asphaltum paint. Other approved protection material may be used if approved by the Department.

530.03 Construction Requirements.

(a) General.

1. Pipe Inspection.

Pipe shall be laid only in the presence of the Engineer or his authorized representative, and shall not be covered until approved. Pipe installed contrary to this requirement will be rejected and shall be replaced by the Contractor without additional compensation.

2. Grade and Alignment.

The pipe shall be laid with ends abutting and with not more than a 1 inch {25 mm} variation from established alignment at the vertical centerline or from grade at the flowline. The Engineer will provide in the designated grade sufficient camber to prevent development of sag or reverse slope due to foundation settlement under embankment load.

3. Pipe Culvert Extensions.

The Contractor shall extend existing pipe culverts using the same construction methods and materials required for the installation of new pipe culverts. A pipe that extends from an existing manhole, inlet, or junction box, and a pipe that is extended from the installation of a collar shall be a pipe extension. A pipe that is extended from the installation of a new junction box is not a pipe extension and will be considered to be just a roadway pipe.

4. Depth of Fill.

The fill height for determining the class or wall thickness of pipe will be the distance from the elevation of the top of the pipe to elevation at the top of the base course.

5. Coated, Paved Invert, and Concrete Lined Pipe.

In the installation of coated, paved invert, or concrete lined pipe, care shall be taken not to damage the protective coating, lining, or the paved invert. Any damage shall be repaired with approved material or replaced as directed.

6. Corrugated Steel or Corrugated Aluminum Pipe.

Where aluminum pipe is to be connected to galvanized or other metal pipe, the surfaces shall be separated from contact by an approved type of gasket.

7. Galvanized Pipe.

Any damage to galvanizing shall be painted with two coats of approved galvanizing repair paint, Section 855, or approved zinc spelter paint.

(b) Excavation of Trench.

Details of trenching and bedding of pipe will be shown on the plans. All pipe 48 inches {1200 mm} or less in horizontal diameter shall be laid in a trench extending at least 1 foot {300 mm} above the elevation of the top of the pipe. For such pipe, where the ground surface is less than 1 foot {300 mm} above the elevation of the top of the pipe, the Contractor shall first construct and compact the fill to a minimum height of 1 foot {300 mm} above the elevation of the top of the pipe and for a minimum distance of 10 feet {3 m} in each direction from the outside edge of the pipe. The trench shall then be excavated as specified in Section 214. Caution shall be used to keep the sides of the trench vertical and to specified dimensions. Extra wide excavation to accommodate pans or other unsuitable excavating equipment will not be permitted. Excavation above subgrade will be classified and paid for as roadway excavation. Excavation below subgrade will be classified and paid for as structure excavation except that no payment will be made for excavating that part of a fill section placed more than 1 foot {300 mm} above the top of the pipe.

For pipe over 48 inches {1200 mm} in horizontal diameter, trenching will be required only where the original ground is above the elevation of the bottom of the pipe, and backfilling shall be performed as specified in Item 210.03(d)2.

Should the material encountered at the elevation of the trench floor not be suitable to support the structure, removal of unsuitable material and placement of foundation backfill shall be performed and will be paid for as specified in Section 214. Temporary drainage necessary for proper installations shall be provided by the Contractor without additional compensation.

(c) Pipe Bedding.

1. General.

   All pipe culverts placed under this Section shall be placed in a prepared bed of one of the types noted herein. Unless otherwise provided, a Class "C" Bedding shall be used.

2. Class A Bedding.

   The pipe culvert shall be bedded in a continuous concrete cradle conforming to plan details.

3. Class B Bedding.

   The pipe shall be bedded with ordinary care in a prepared foundation bed to a depth of not less than 30 percent of the vertical diameter of the pipe plus 4 inches {100 mm}. The thickness of the foundation bed shall be a minimum of 4 inches {100 mm} in thickness and shall be shaped to fit the pipe for at least 15 percent of the vertical outside diameter. Recesses in the trench bottom shall be shaped to accommodate the bell of the pipe when bell and spigot type pipe is used.

   "Ordinary" care in this Article shall mean sufficient care to insure that the permissible variations listed in Item 530.03(a)2 will not be exceeded.

   The bedding material shall be sand or an approved selected sandy soil.

4. Class C Bedding.

   The pipe shall be bedded with ordinary care in a loosened soil foundation shaped to fit the lower part of the pipe exterior with reasonable closeness for at least 10 percent of its overall height. Use of a template for shaping will not be required. The shaped foundation shall be loosened by pulverizing the soil to a minimum depth equal to 0.125 times the diameter of the pipe or 3 inches {75 mm} maximum. "Ordinary care" in this Article shall mean sufficient care to insure that the permissible variations listed in Item 530.03(a)2 will not be exceeded.

   Where ledge rock, rocky or gravelly soil, hard pan, or other unyielding foundation material is encountered at a culvert site, the pipe shall be bedded as follows: The hard unyielding material shall be excavated below the elevation of the bottom of the pipe, or pipe bell, for a depth of at least 12 inches {300 mm}, or 1/2 inch for each foot {40 mm for each meter} of fill over the top of the pipe, whichever is greater, but not more than 24 inches {600 mm}. Payment for this material shall be made under Structure Excavation. The width of the excavation shall be 12 inches {300 mm} greater than the outside diameter or span of the pipe and shall be filled with selected fine compressible material, such as silty clay or loam taken from selected grading operations or areas beyond the right of way and paid for as Foundation Backfill. This material shall then be lightly compacted in 6 inch {150 mm} compacted lifts and shaped as specified above.

(d) Placing Pipe.

1. General.

   Proper facilities shall be provided for lowering the sections of pipe into the prepared trench.

The pipe laying shall begin at the downstream end of the pipe line. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing upstream. Flexible pipe shall be placed with longitudinal laps or seams at the sides.

Paved invert pipe shall be laid so that the longitudinal center line of the paved segment coincides with the designated flow line.

All flexible (C.S. or C.A.) pipes 48 inches {1200 mm} or larger in diameter shall be shop elongated or field strutted except for arch pipe and concrete lined pipe. Details for field strutting shall be as provided by the plans and shall be accomplished prior to placing any embankment adjacent to the structure. Only horizontal ties shall be used in strutting paved invert pipe. The pipe shall be laid in the trench with the separate sections firmly joined together and with outside laps of circumferential joints pointing up stream and with longitudinal laps on the sides. Any metal in joints which is not protected by galvanizing shall be coated with suitable asphaltum paint. If headwalls are to be placed, the ends of the pipes laid on a skew shall be neatly cut off parallel with the centerline of the highway and flush with the outside face of the headwalls.

2. Multiple Pipe Culverts.

Where multiple lines of pipe are used, they shall be spaced far enough apart to permit thorough tamping of earth between adjacent lines. To this end the adjacent sides of circular pipe shall be at least 0.5 times the nominal pipe diameter apart, or 3 feet {1 m}, whichever is less. Spacing for arch pipe shall be as shown on the plans.

3. Joining Pipe.

a. Rigid Pipe (Concrete, C.I.)

Rigid pipe may be of bell and spigot, tongue and groove, or other approved design unless a specific type is specified. The method of joining pipe sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be sealed with bituminous plastic cement, preformed flexible sealant, rubber gaskets, or other type sealers that may be approved. Joints shall be thoroughly cleaned before being sealed and shall be sealed for the full circumference of the joint unless otherwise directed.

When joining round R.C. pipe, only rubber gaskets shall be used unless otherwise approved by the Engineer.

When bituminous plastic cement is used, the interior surface of the hub, beginning at the lip of the normal interior surface of the pipe, shall be coated with a layer of sealing material that will cover at least 0.33 times the distance, measured along the surface of the hub, parallel to the normal length of the pipe. The thickness of the mastic placed shall be such that it will provide a uniform seal between the edges of the pipe sections being joined (approximately 1/2 of an inch {10 mm} on the inside shoulder of the hub and approximately 1/8 of an inch {3 mm} of material on the remaining area to be covered).

When Pre-formed flexible sealant is used it shall be placed according to the manufacturers requirements.

No joint shall be considered satisfactory when the space between the edges of the pipes being joined exceeds 1/2 of an inch {10 mm} for more than 0.33 times the circumference of the pipe. The inside of the joint shall be wiped and finished smooth.

Rubber or other types of gaskets shall be installed as recommended by the manufacturer,

b. Flexible Pipe (C.S., C.A.)

Flexible pipe shall be firmly joined by coupling bands of an approved type. Joints shall be thoroughly cleaned before being joined and shall be sealed for the full circumference of the joint with an approved sealer unless otherwise directed.

4. Inspection.

All pipe shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be taken up and relaid or replaced.

(e) Backfilling Pipe.

1. General.

After the pipe has been installed, the pipe trench shall be backfilled with the best of the suitable material excavated from the trench; if none of this excavated material is suitable,

material from the roadway shall be used and paid for as such, or suitable material shall be hauled in and used with payment being made under the classification of the material ordered used. For backfilling above a point 1 foot {300 mm} above the top of the pipe, material from the trench may be used unless unsuitable for embankment.

Backfilling will not be permitted until authorized by the Engineer.

2. Placing and Compaction of Backfill.

The backfill material shall be compacted at near optimum moisture content, in layers not exceeding 6 inches {150 mm} compacted thickness, to a density of not less than 95 percent of AASHTO T 99 density by methods detailed in Section 210. Mechanical tampers shall be used unless another method of compaction is approved in writing; inundation or jetting will not be permitted unless specified on the plans. Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the material is in intimate contact with the pipe. The backfill shall be brought up evenly in layers on both sides of the pipe for its full length until the trench is filled or up to subgrade elevation if the trench is in cut.

When the plans require stone or aggregate backfill, the material will be compacted (in layers not exceeding 6 inches) to the satisfaction of the Engineer. Mechanical tampers or vibrator plate compactors shall be used unless another method of compaction is approved in writing.

When the top of the pipe is exposed above the top of the trench, embankment material shall be placed and compacted for a width on each side of the pipe equal to at least twice the horizontal inside diameter of the pipe, or 12 feet {4 m} whichever is less. The embankment on each side of the pipe, for a distance equal to the horizontal inside diameter of the pipe, shall be of the same material and compacted in a normal manner. All pipe, after being bedded and backfilled as specified in this Section, should be protected by a 3 foot {0.6 m} cover of fill before heavy equipment is permitted to cross during construction of the roadway.

3. Protection of Pipe.

The Contractor shall exercise necessary care in installing and backfilling pipe, and it shall be his responsibility to see that the pipe is not damaged by lateral forces during backfilling, by heavy loads operating over the pipe, or by other causes. All damaged pipe shall be replaced or repaired by the Contractor at his own expense at the option of, and to the satisfaction of, the Engineer.

Any pipe not true to designated alignment and grade within specified tolerances, or any pipe that shows settlement due to faulty installation, shall be relaid or replaced by the Contractor without additional compensation. Any pavement that settles or breaks over a pipe shall be replaced or repaired by the Contractor, at the option of the Engineer, without additional compensation. All pipe lines shall be thoroughly cleaned out prior to final acceptance.

(f) Jacking (Boring) Pipe.

For pipe sizes less than 42 inches {1050 mm} in diameter, the tunneling equipment used in the jacking (boring) operation shall have a steerable cutting head equipped with a grade indicator. For pipe sizes 42 inches {1050 mm} in diameter and greater, the tunneling equipment used in the jacking (boring) operation shall be a laser-guided tunnel boring machine (TBM). The use of unguided auger-type boring equipment will not be permitted. The tunneling equipment shall also be equipped with a closed-face cutting head or otherwise equipped to prevent unstable soils from entering the tunnel.

The tolerance for grade control shall be plus or minus 0.020 feet per 100 feet {20 mm per 100 m} of length. The tolerance for line shall be 0.20 feet per 100 feet {200 mm per 100 m} of length.

Smooth steel pipe shall be continuously welded at joints to form a rigid, watertight installation. Any coating disturbed during the welding procedure shall be repaired, both inside and outside, in a manner acceptable to the Engineer.

530.04 Method of Measurement.

The accepted length of pipe culverts laid as ordered will be measured along the bottom flowline, or invert, of the pipe complete in place. Measurements will be made between inside walls of designated structures (junction boxes, inlets, etc.) and along the centerline of the flowline of special fittings (elbows, wyes, etc.). The above applies to round or arch, beveled or unbeveled, pipe. However, in no case will measurement be made for lengths greater than the sum of the nominal laying lengths of the pipe sections used or for lengths greater than the length of culvert ordered by the Engineer. No separate measurement for payment will be made for the excavation and/or backfill volume needed to reroute water for temporary drainage which might be necessary for the proper installation of the pipe or to perform the imperfect trench method of installation.

Structure excavation and foundation backfill, including that necessary for the installation of roadway pipe of a temporary nature, when ordered will be measured and paid for as prescribed in Section 214.

The accepted length of pipe culverts jacked (bored) as ordered and acceptably installed will be measured along the bottom flowline, or invert, of the pipe complete in place. The limits of measurement of jacked (bored) pipe under this Section will not exceed the length along the flowline of the pipe from face to face of the boring pit or the length shown on the plans, except as otherwise directed in writing by the Engineer, whichever is less. There will be no separate measurement for payment for structure excavation and foundation backfill for pipe installed by the jacking (boring) method.

530.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted length of pipe culverts, measured as above provided, will be paid for at the respective contract unit prices for the various sizes, and types of pipe provided in the proposal, complete in place, which shall be payment as herein provided and also for all work, equipment, materials, and incidentals connected with the execution of the Class Bedding specified for installation, except that Foundation Backfill and Structure Excavation shall be paid for separately.

(b) Pipe Size, Class, Bedding, and Optional Types.

The internal diameter of circular pipe, the span and rise of arch pipe, the class of pipe, the class of pipe bedding, if other than Class "C", and the type or types of pipe allowed will be shown in the item name.

The internal diameter of jacked (bored) pipe and the type or types of pipe allowed will be shown in the item name.

(c) Payment will be made under Item No.:

530-A ___ inch {mm} Roadway Pipe, Class __* Bedding (__**) - per linear foot {meter}

530-B ___ inch {mm} Span, ___ inch {mm} Rise Roadway Pipe, Class __* Bedding (__**) - per linear foot {meter}

530-C _____ inch {mm} Roadway Pipe, Jacked Installation (***) - per linear foot {meter}

* If other than Class "C", so note.

** Show acceptable types of pipe.

*** Specify "Smooth Steel", "Class __ R.C.", etc. if applicable.

Examples:

Specific Type: Class ____ R.C., or ____ gage {mm} C.C.S.P.I., or ____ gage {mm} C.C.S., or ____ gage {mm} C.C.A.P.I., or____ gage {mm} C.C.A.

Optional Types: Class ____ R.C. or equal strength C.C.M.P.I. or Class ____ R.C. or equal strength C.C.M.

SECTION 531
CORRUGATED METAL STRUCTURAL PLATE PIPE, ARCH PIPE, AND ARCH CULVERTS

531.01 Description.

This Section shall cover the work of furnishing corrugated metal structural plate pipe, arch pipes, and arches (coated and uncoated) of the sizes, plate thickness, and dimensions required by the plans and installing such at the locations shown by the plans or designated, all in conformity with these specifications to the lines and grades given. The corrugated metal plate pipe shall be full circle or other approved pipe shapes. Corrugated metal plate arches shall be part of circle construction anchored on footings, floor, or grillage of description shown on the plans.

531.02 Materials.

All materials shall conform to the provisions of Division 800, Materials. Specific reference is made to Section 841, Corrugated Metal Structural Plate for Pipe and Arches.

531.03 Construction Requirements.

(a) General.

The pipe or arch structure shall be carefully erected according to plans and erection drawings and true lines and grades, as given, on approved foundations. Arches shall be set in galvanized steel shapes on concrete or masonry footings, or on timber grillages or concrete floors built in full compliance with the specifications for Sections 501, 509, or 611. The structure shall be erected on its permanent foundations.

(b) Erection.

Structural plate pipe, pipe arches, and arches shall be erected in their final position by connecting the plates with bolts at longitudinal and circumferential seams. Drift pins may be used to facilitate matching of holes. Each plate shall have legible identification numerals to designate its position in the structures. All plates shall be placed in the order recommended by the manufacturer with joints staggered so that not more than three plates come together at any one point. All bolts shall be drawn tight before beginning the backfill and shall have not less than 200 nor more than 300 foot-pounds {270 nor more than 400 N•m} of torque in their final tightening for steel plate or not less than 100 nor more than 150 foot-pounds {135 nor more than 200 N•m} for aluminum plates.

(c) Excavation, Bedding and Backfill.

This work shall be performed as specified in Section 530.

(d) Elongation or Strutting.

All structural plate pipes of 60 inches {1500 mm} or larger diameter shall be shop-elongated or field strutted as shown on the plans. Strutting shall be accomplished prior to placing any embankment adjacent to the structure. Strutting will not be required where required elongation has been fabricated into the plates at the factory. Elongation or strutting of plate arch pipe will not be required. Elongated pipe shall be installed with the longer axis vertical.

531.04 Method of Measurement.

Corrugated metal structure plate pipe, arch pipe, and arch culverts, structure excavation, and foundation backfill will each be measured in the same manner as specified in Article 530.04.

531.05 Basis of Payment.

(a) Unit Price Coverage.

The length, determined as above described, will be paid for at the contract unit prices per meter for corrugated structural plate pipe, arch pipe, or arch culverts of the several sizes, as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, erecting, installing, and backfilling the pipe or arches, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item, but will not constitute payment for any concrete, masonry, steel reinforcement, or excavation.

(b) Payment will be made under Item No.:

531-A ___ inch {mm} , ___ inch {mm} Plate B.C. If Applicable
Corrugated Steel or Aluminum P.I. If Applicable Structural Plate Pipe
- per linear foot {meter}

531-B ___ inch {mm} Span, ___ inch {mm} Rise, ___ inch {mm} Plate B.C. If Applicable
Corrugated Steel or Aluminum P.I. If Applicable Structural Plate Arch Pipe
- per linear foot {meter}

531-C ___ inch {mm} Span, ___ inch {mm} Rise, ___ inch {mm} Plate B.C. If Applicable
Corrugated Steel or Aluminum Structural Plate Arch - per linear foot {meter}

SECTION 532
SLOTTED DRAINS

532.01 Description.

This Section shall cover the work of furnishing and installing a slotted drain which provides a drainage slot along the longitudinal section of the drain. This drainage slot shall be formed by either the angle slot design or the grate slot design as shown by plan details. Unless the plans or proposal designates

which design to use or requires a special design, the Contractor shall have the option to select either design, but once selected, the same design shall be used throughout the project. When required by the plans, the Contractor shall furnish and install a specified special design slotted drain. Also when required by the plans, the Contractor shall furnish and install a special design slotted drain which provides a variable height drainage slot along the longitudinal section of the drain.

532.02 Materials.

The materials for the slotted drain shall meet the requirements shown on Special Drawing No. CSP-532 and the requirements given in this Section.

The Department has established a list of products approved for use. These products can be found on List II-16, SLOTTED DRAIN PIPE, of the Department's manual, "Materials, Sources, and Devices With Special Acceptance Requirements" (available from the Bureau of Materials and Tests). The Contractor may choose from any of these products, unless otherwise noted.

Backfill material shall be Class A concrete meeting the requirements of Section 501. Job Control test cylinders will not be required for this concrete.

532.03 Construction Requirements.

(a) General.

1. Connections to Existing Structures.

   Connections to existing structures may require the use of a transitional fitting and/or section(s) of pipe to provide a suitable connection without damage to the grates or drains, etc. of the structures.

2. End Seals.

   When the drain or pipe begins or terminates without a connection to other pipes or drainage structures, the pipe end shall be sealed or plugged with a suitable cap as shown on plan details, properly connected to provide a waterproof connection.

(b) Slotted Drain Pipe.

This type pipe is designed to be placed with the slotted drain at or near the pavement, shoulder, or median surface.

The general construction requirements of Article 530.03 are applicable except as modified by the following:

- Excavation shall be kept as nearly as possible to the minimum width, depth, and length shown on the plans.
- The pipe shall be supported or held in place in such a manner as to permit flow of the concrete backfill material around the pipe.
- The drainage slot shall be protected during installation by a removable wood strip, heavy duty tape, or other suitable material adequately performing the intended function, affixed to the slot to prevent infiltration of material into the pipe. After finishing the surface, the protective covering shall be removed.
- Under no circumstances shall any portion of the slot extend above the paving material or curb and gutter section.

Joints for corrugated steel slotted drain pipe shall be made using approved connecting bands meeting the requirements of Subarticle 850.02(d).

532.04 Method of Measurement.

The accepted length of slotted drain laid as ordered will be measured in linear feet along the bottom flowline, or invert, of the slotted drain complete in place. Connections to other structures (i.e. elbows, pipe, joints, etc.) will not be measured for payment unless shown otherwise on the plans. Excavation and backfill will not be measured for payment.

532.05 Basis of Payment.

(a) Unit Price Coverage.

Slotted Drain, measured as noted above, will be paid for at the contract unit price bid complete in place, which shall be full compensation for fabricating, furnishing and installing a slotted drain meeting the requirements noted herein and the details shown on the plans (this includes a variable height grate or special design drain when required), for furnishing and installing connections to other structures (when required), for all excavation, backfill, satisfactory disposal of surplus materials, and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

532-A ___ inch {mm} ___* Slotted Drain Pipe (___**) - per linear foot {meter}

* Specify " Corrugated Steel", "Concrete", "(*Specify the Special Design*)", etc., only if applicable.

** Specify "With Variable Height Grate", etc., if applicable.

SECTION 533
STORM SEWERS

533.01 Description.

This Section shall cover the work of furnishing and constructing storm sewers of the kind, strength, and size pipe provided in the proposal, in accordance with the requirements of these specifications and installing such sewers at the locations shown on the plans or designated and in conformity with established lines and grades. These items shall also include the furnishing and construction of such joints, necessary cutting and connections to other pipe, catch basins, endwalls, etc., as may be required to complete the work shown on the plans or directed.

533.02 Materials.

(a) General.

Materials furnished for use shall conform to the appropriate provisions of Division 800, Materials, with specific reference made to Section 854.

(b) Abbreviations:

Concrete Pipe	P.C. for plain concrete R.C. for reinforced concrete
Corrugated Metal	C.M. for any acceptable corrugated metal pipe covered by these specifications
Protective Coating	C. for any protective coating of metal pipe allowed by these specifications
Paved Invert	P.I.
Corrugated Steel	C.S. for Plain Corrugated Steel C.C.S. for Coated Corrugated Steel C.C.S.P.I. for Coated C.S. Paved Invert
Corrugated Aluminum	C.A. for Plain Corrugated Aluminum C.C.A. for Coated C.A. C.C.A.P.I. for Coated C.A. Paved Invert
Smooth Lined	S.L. for Smooth Lined C.S.L.C.M. for Coated, Smooth Lined Corrugated Metal C.S.L.C.S. for Coated, Smooth Lined Corrugated Steel C.S.L.C.A. for Coated, Smooth Lined Corrugated Aluminum
Smooth Flow	S.F. for Smooth Flow C.S.F.C.M. for Coated, Smooth Flow Corrugated Metal C.S.F.C.S. for Coated, Smooth Flow Corrugated Steel C.S.F.C.A. for Coated, Smooth Flow Corrugated Aluminum
Concrete Lined	C.L. C.C.L.C.S. for Coated C.L. Corrugated Steel
Vitrified Clay	V.C. for Vitrified Clay
High Density Polyethylene	HDPE for High Density Polyethylene
High Performance Polypropylene	PP for High Performance Polypropylene

(c) Optional Types of Pipes

Provided a specific type of pipe is not specified by the plans or proposal, the Contractor will be permitted to install any of the optional types of pipe herein. Substitutions will only be allowed with hydraulically equivalent pipes. The hydraulic equivalence of optional types of pipes will be shown on the plans. Optional types of pipe shall meet the following criteria:

Diameters less than or equal to 24 inches {600 mm} - P.C.; V.C.; Class 1 C.S.L.C.M.; 16 gage {1.6 mm} C.S.F.C.M.; 16 gage {1.6 mm} C.C.L.C.S., P.V.C.; or HDPE.

Diameters greater than24 inches {600 mm} - Class 2 R.C.; Class 2 C.S.L.C.M.; 14 gage {2.0 mm} C.S.F.C.M.; 14 gage {2.0 mm} C.C.L.C.S.; P.V.C. or HDPE, or PP (HDPE and PP up to 36 inches {900 mm} diameter) with a minimum of 24 inches {600 mm} of cover, and a maximum of 25 feet {7.5 m} fill height . Any storm sewer pipe to be placed under a roadway or subject to continuous traffic shall be not less than a Class 3 R.C., or equivalent strength C.S.L.C.M., C.S.F.C.M., or C.C.L.C.S. Pipe. The fill height charts on the plans for roadway pipe shall be used to determine strengths or equivalent strengths for storm sewer pipe.

All smooth flow pipe 48 inches {1200 mm} or larger in diameter shall be shop elongated.

The Contractor may furnish a higher grade pipe than those specified above or, with written approval, a cast iron or ductile iron pipe meeting the appropriate requirements of Section 854, provided no additional cost is incurred by the Department for such substitution. Any installation, once started, shall be completed using the same type of pipe unless specifically designated otherwise by plan details or requested and approved in writing.

533.03 Construction Requirements.

(a) General Methods.

Pipe shall not be laid except in the presence of the Engineer or Inspector and shall not be covered until approved.

Any sewer line placed under a roadway or subject to continuous traffic shall be placed in accordance with the appropriate provisions of Article 530.03.

(b) Excavation and Foundation.

1. Excavation.

The trench shall be excavated beginning at the outlet end and proceeding upgrade, true to the established line and grade. Tunneling will not be permitted unless authorized in writing. The removal of trees or other obstructions encountered necessary for the construction of the work shall be done by the Contractor without extra compensation. Trenches shall be properly sheeted and braced wherever needed. Unless otherwise directed, the trench shall be of the size, within the limits, provided by Subarticle 214.04(a).

2. Foundation.

If deemed necessary, foundation backfill as provided by Article 214.02 shall be used. The foundation in the trench shall be so formed and treated as to prevent subsequent settlement. If the foundation is in rock, foundation backfill consisting of a 12 inch {300 mm} cushion of well compacted sand, fine gravel, slag, broken stone, or other approved material shall be placed upon the rock. If the excavation has been made deeper than necessary, proper bearing shall be secured by means of a layer of fine gravel, or other suitable material. In all cases recesses shall be formed to receive the bell or hub, so that the full length of the pipe barrel will rest on the trench bottom.

(c) Laying Pipe.

1. General.

The laying of pipes in finished trenches shall be started at the outlet end and proceed upgrade so that the spigot or groove ends point in the direction of flow. All pipes shall be laid with ends abutting and with not more than 1 inch {25 mm} variation from established alignment at the vertical centerline or from grade at the flow line. The bottom of the trench shall be shaped accurately to the outside surface of the pipe for a depth at least 0.10 times the outside diameter. Pipes shall be fitted and matched so that when laid in the work they will form a sewer with a smooth, uniform invert. Hubs or bells shall be carefully cleaned before pipes are lowered into the trenches. Pipe shall be so lowered as to avoid damage and unnecessary handling in the trench.

2. Sealing Joints.

Unless otherwise directed, all joints shall be sealed as specified in Item 530.03(d)3 for the entire circumference of the pipe. PVC pipe joints may be thermally fused if installed according to the pipe manufacturer’s recommendations. Trenches shall be kept free from water until mortar in the joints and masonry has hardened. Walking or working on or over the completed pipe line, except such as is necessary for tamping or backfilling, will not be permitted until at least 3 feet {1 m} of backfill is in place over the pipe.

(d) Backfilling.

1. Material.

All trenches and excavations shall be backfilled with approved natural soil or, if directed or provided by the plans, with foundation backfill material after the sewer pipe is laid therein, unless otherwise specified.

2. Methods.

Backfilling shall not begin until mortar joints have cured or until backfilling is authorized by the Engineer. The material shall be carefully deposited simultaneously on both sides of the pipe in uniform layers not to exceed 6 inches {150 mm} in compacted thickness, solidly tamped or rammed with proper tools so as not to injure or disturb the pipe. If stone, gravel, or slag is provided or specified as backfilling, the sewer pipe shall be covered with clean gravel or broken stone or slag placed around and above it to a height of not less than 4 inches {100 mm} above the upper surface of the pipe. The remainder of the trench shall then be backfilled with the excavated material. The Contractor shall restore all roadways or crossings, which are disturbed by the placing of sewers, to their original condition and shall replace all surface material and all paving, macadam, sidewalk, sod, or other surface disturbed, furnishing all the new material necessary without extra compensation, except as herein provided. Whenever excavation is made for installing sewer pipe across private property, the topsoil disturbed by excavation operations shall be replaced as nearly as possible in its original position.

Bedding, placing, and backfilling of storm sewers within roadway limits shall be as provided in Section 530, using the type and strength of pipe specified on the plans.

3. Compaction and Density.

Compaction and density requirements shall meet that specified by Article 530.03. Ramming of material over, around, and to within 1 foot {300 mm} above the top of the sewer shall be done by careful use of approved mechanical tampers.

4. Clean Up.

After completing the backfill, the Contractor shall immediately remove all surplus material, dirt, rubbish, and all tools and other equipment or material, leaving the entire site and the whole area involved in the construction operations in a neat and presentable condition. All pipe lines shall be thoroughly cleaned out prior to final acceptance.

(e) Testing For Excessive Deformation in P.V.C., HDPE, and PP Pipe.

P.V.C. HDPE, and PP pipe shall be tested for excessive deformation. The test shall be performed by the Contractor in the presence of the Engineer. Testing shall be conducted no fewer than 30 days after the completion of the compaction of all fill over the pipe.

The Contractor shall conduct the test by pulling a nine point mandrel through the entire length of the pipe by hand.

The mandrel shall meet the following requirements:

- It shall be made of steel or aluminum;
- It shall have an effective diameter of 95 % of the nominal inside diameter of the pipe;
- It shall be at least as long as the diameter of the pipe;
- It shall be fitted with pulling rings at each end;
- It shall be stamped or engraved on some segment other than a runner with the pipe size and mandrel outside diameter.

Prior to testing, the Contractor shall provide the Engineer with a proving ring to verify the mandrel size.

The deformation is unacceptably excessive if the mandrel cannot be pulled through the pipe by hand without damaging the pipe. If the deformation is unacceptably excessive, the pipe shall be replaced without extra compensation.

There will be no direct payment for testing.

533.04 Method of Measurement.

Storm sewer pipe, excavation, and foundation backfill will each be measured in the same manner as specified in Article 530.04.

533.05 Basis of Payment.

(a) General.

The accepted length of a storm sewer pipe, measured as specified above, will be paid for at the respective contract unit price for the sizes and types of pipe provided in the proposal, complete in place, which shall be payment in full for all materials, equipment, labor, and incidentals necessary to complete the work, except that excavation and backfill will be paid for as provided in Section 214.

(b) Payment Will Be Made Under Item No.:

533-A ___ inch {mm} Storm Sewer Pipe (*) - per linear foot {meter}
533-B ___ inch {mm} Span, ___ inch {mm} Rise Storm Sewer Pipe (*) - per linear foot {meter}
* Show specific type, if required. Example: P.C. or V.C., or Class ____ R.C., or Class ____ C.S.L.C.S., or Class ____ C.S.L.C.A., C.S.F.C.S., C.S.F.C.A., or C.C.L.C.S.

SECTION 534
CLEANING EXISTING DRAINAGE STRUCTURES

534.01 Description.

This Section shall cover the work of cleaning existing drainage structures including all types of pipes, reinforced box culverts, underdrain outlets and other drainage structures shown on the plans.

534.02 Materials.

There will be no material requirements other than the hardware cloth for the rodent screens on underdrain outlets shown on the plans.

534.03 Construction Requirements.

Pipes, box culverts, catch basins, manholes, drop inlets, pipe underdrain outlets and other drainage structures shown on the plans shall be cleaned of all dirt, leaves, limbs, roots, grass, sludge, grease, trash and other debris. Obstructions within a 5 foot distance outside of the inlet and outlet ends of the drainage structures shall also be removed as a part of cleaning the structures.

All materials removed during cleaning shall be disposed off of the right-of-way in accordance with the requirements for disposal given in Section 206. The Contractor shall implement the "Best Management Practices" (BMP's) noted in Section 107 for the control of sediment that will be removed during the cleaning.

The Contractor shall perform the work so that there is always adequate drainage of the roadway at all times.

The Contractor shall repair all damage to drainage structures that result from cleaning methods and procedures that are used without consideration for the protection of the drainage system. The Engineer will not allow the use of any cleaning method or equipment that may result in damage to the structure or damage to the areas adjacent to the structure.

Rodent screens shall be fabricated and installed as shown on the plans or as directed by the Engineer.

534.04 Method of Measurement.

The cleaning of existing pipes, box culverts, catch basins, manholes, drop inlets, pipe underdrain outlets and other drainage structures will be measured per each drainage structure or per foot along the length of the drainage structure.

Measurement will be made only once for each item cleaned unless severe conditions result in the need for repeated cleaning and the repeated cleaning is not caused by the activities of the Contractor. All recleaning due to the activities of the Contractor shall be done at no additional cost to the Department.

Pipes, culverts and other drainage structures measured for cleaning along the length of the structure will be classified for payment based on the horizontal opening of the drainage structure.

The diameter of round pipe and the span of "span and rise" pipe will be shown as a horizontal opening classification for payment. Each pipe will be measured separately for payment regardless of the number of pipes adjacent to each other at one location.

The horizontal opening of a culvert will also be shown as a classification for payment. The horizontal opening of a culvert shall be the horizontal opening in a single barrel culvert or the sum of the horizontal openings in a multiple barrel culvert.

Two classifications of horizontal opening will be given for the purpose of measurement for payment. The first classification of horizontal opening shall be structures with an opening less than or equal to 48 inches. The second classification of horizontal opening shall be structures with an opening greater than 48 inches.

If separate pay items are not shown on the plans for cleaning catch basins, manholes, and other appurtenances to the structures measured by linear feet (pipes and culverts), the cleaning of these appurtanancies will be measured for payment by including the length through the appurtenances in the total number of linear feet of the attached drainage structure. The length through an appurtenance will be added to the length of the largest structure connected to the appurtenance.

534.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for cleaning existing drainage structures shall be full compensation for all materials, tools and labor required for cleaning the structures, disposing of all materials that are removed from the structure and installing new rodent screens.

(b) Payment will be made under Item No.:

534-A Cleaning Pipe Underdrain Outlets - per each
534-B Cleaning Existing Catch Basin - per each
534-C Cleaning Existing Manhole - per each
534-D Cleaning Existing Drop Inlet - per each
534-E Cleaning Existing ___*___ (Less Than Or Equal To 48" Horizontal Opening) - per linear foot
534-F Cleaning Existing ___*___ (Greater Than 48" Horizontal Opening) - per linear foot
* Pipe, Culvert, etc.

SECTION 535
SIDE DRAIN PIPE

535.01 Description.

This Section shall cover the work of furnishing and installing side drain pipe in conformity with these specifications. The word "pipe" in this Section shall include both round and arch pipe. It shall cover only those pipes specifically designated on the plans as side drain; it shall not apply to other pipes laid parallel to the roadway. The kind, type, and size of each side drain pipe will be shown on the plans or in the proposal. The location of each will be shown on the plans or designated. This Section shall include furnishing and constructing such joints and necessary cutting to provide connections to other drainage facilities, and other incidentals necessary for completion of the work.

535.02 Materials.

(a) General

Materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, with specific reference made to Sections 831, 846 and 851.

(b) Abbreviations:

Side Drain	SD
Concrete	PC for Plain Concrete Pipe RC for Reinforced Concrete Pipe
Vitrified Clay	VC
Corrugated Metal	CM for Plain Corrugated Metal CCM for Coated Corrugated Metal
Corrugated Aluminum	CA for Plain CCA for Coated
Corrugated Steel	CS for Plain CCS for Coated
Plastic	ABS for Acrylonitrile Butadiene Styrene

	HDPE for High Density Polyethylene PP for High Performance Polypropylene PVC for Polyvinyl Chloride

(c) Optional Types of Pipes.

Provided a specific type of pipe is not specified by the plans or proposal, the Contractor will be permitted to install any of the optional types of pipe herein. Substitutions will only be allowed with hydraulically equivalent pipes. The hydraulic equivalence of optional types of pipes will be shown on the plans. Optional types of pipe shall meet the following criteria:

- Diameters less than or equal to 24 inches {600 mm} – P.C.; V.C.; 16 gage {1.6 mm} C.M. with greater than or equal to 24 inches {600 mm} of cover, 14 gage {2.0 mm} CM with less than 24 inches {600 mm} cover; or P.V.C., A.B.S. or HDPE, or PP pipe (HDPE and PP up to 36 inches {900 mm} diameter) with minimum of 24 inches {600 mm} of cover, and maximum of 25 feet {7.5 m} fill height.
- Diameters greater than 24 inches {600 mm} - Class 2 R.C.; V.C.; 14 gage {2.0 mm} C.M. ; P.V.C. or HDPE and PP(HDPE and PP up to 36 inch {900 mm} diameter) with a minimum of 24 inches {600 mm} of cover, and a maximum of 25 feet {7.5 m} fill height.

Higher strength and/or coated finish CM pipe when required will be noted in the pay item. The Contractor may, at his option, substitute a higher grade pipe than specified or, with written approval, a cast iron or ductile iron pipe meeting the appropriate requirements of Section 854, provided no additional cost is incurred by the Department for such substitution.

Any installation, once started, shall be completed using the same type of pipe unless specifically designated otherwise by plan details or requested and approved in writing.

535.03 Construction Requirements.

(a) General.

Construction details for installing side drain pipe shall be as specified in Section 530, except as modified in this Section.

The requirements of Subarticle 530.03(b) for partial construction of fills in advance of trenching will not apply. Trenches shall be excavated as specified in Section 214. No separate measurement or direct payment will be made for excavation and backfill of trenches for side drain pipes.

Special bedding will not be required; however, the pipe shall be bedded with ordinary care in the loosened soil foundation of the trench. Should the material at the elevation of the bottom of the pipe be ledge rock or other unsuitable bedding, it shall be excavated without additional compensation.

The pipe shall be installed so that it will not vary at any point more than 1 inch {25 mm} from established line and grade.

The pipe shall be backfilled in thoroughly compacted layers not more than 6 inches {150 mm} in thickness, using pneumatic tamps unless otherwise directed, but there will be no specific density requirements. Backfill shall be ordinary excavation material.

(b) Testing for Excessive Deformation in PVC, HDPE, and PP Pipe.

PVC, HDPE, and PP pipe shall be tested for excessive deformation. The test shall be performed by the Contractor in the presence of the Engineer. Testing shall be conducted no fewer than 30 days after the completion of the compaction of all fill over the pipe.

The Contractor shall conduct the test by pulling a nine point mandrel through the entire length of the pipe by hand.

The mandrel shall meet the following requirements:

- It shall be made of steel or aluminum;
- It shall have an effective diameter of 95 % of the nominal inside diameter of the pipe;
- It shall be at least as long as the diameter of the pipe;
- It shall be fitted with pulling rings at each end;
- It shall be stamped or engraved on some segment other than a runner with the pipe size and mandrel outside diameter.

Prior to testing, the Contractor shall provide the Engineer with a proving ring to verify the mandrel size.

The deformation is unacceptably excessive if the mandrel cannot be pulled through the pipe by hand without damaging the pipe. If the deformation is unacceptably excessive, the pipe shall be replaced without extra compensation. There will be no direct payment for testing.

535.04 Method of Measurement.

Side drain pipe will be measured in the same manner as specified in Article 530.04. Excavation and foundation backfill for side drain pipe will not be measured separately for payment, but the cost thereof shall be included in the contract unit price bid for the side drain pipe.

535.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted side drain pipe, measured as specified above, will be paid for at the contract unit price per foot {meter} for the respective items, which shall be payment in full for furnishing pipe, excavating trenches, placing pipe, backfilling trenches, and for all tools, equipment, labor, and incidentals necessary to complete the work.

(b) Payment Will Be Made Under Item No.:

535-A ___ inch {mm} Side Drain Pipe (*) - per linear foot {meter}
535-B ___ inch {mm} Span, ___ inch {mm} Rise Side Drain Pipe (*) - per linear foot {meter}
* Show specific type, class, or wall thickness, if required.
Example: V.C., or P.C., or Class _____ R.C., or ___ gage {mm} C.A.,
or ___ gage {mm} C.S., or ___ gage {mm} C.C.S., or ___ gage {mm} C.C.A.

SECTION 536
RELAID PIPE

536.01 Description.

This Section shall cover the work of relaying pipe, regardless of size, in accordance with the requirements of these specifications, at the locations shown on the plans or designated and in accordance with established lines and grades. The item shall include furnishing and construction of such joints, necessary cutting and connections to other pipes, the removal and preservation of that portion of pipe culverts, in place, which are to be replaced by new or relaid pipe; it shall also include furnishing and construction of such joints, necessary cutting and connections to other pipes, catch basins, endwalls, etc., as may be required to complete the work shown on the plans or directed.

536.02 Materials.

(a) Salvaged Pipe.

Pipe to be relaid shall be selected salvaged pipe which is approved for relaying.

(b) Joint Material.

An applicable type of joint sealer required by Article 530.02 shall be used.

536.03 Construction Requirements.

(a) Removing Pipe in Place.

Removal of pipe shall be in accordance with the provisions of Article 206.03.

(b) Laying Pipe.

Pipe shall be handled so that there will be no loss or damage, before relaying. Pieces or sections of pipe found satisfactory by the Engineer shall be relaid in accordance with the requirements of the appropriate sections governing culvert pipe. Special reference is made to construction details of Section 530 which are applicable to side drain pipe relaid.

536.04 Method of Measurement.

Relaid pipe will be measured in the same manner as specified in Article 530.04. Excavation and foundation backfill for relaid pipe will not be measured separately for payment, but the cost thereof shall be included in the contract unit price bid for the relaid pipe.

536.05 Basis of Payment.

(a) Unit Price Coverage.

1. The accepted length of relaid culvert pipe, measured as noted above, will be paid for at the contract unit price bid for either roadway pipe relaid or side drain pipe relaid, regardless of size or type of pipe. Said unit costs shall be full compensation for the salvaging of the pipe in conditions for reuse and the re-installation of the pipe in accordance with the provision for roadway pipe as covered by Section 530 and Section 535 for side drain pipe including all equipment, tools, labor, and incidentals necessary to complete the work.

2. No payment will be made for the removal of existing pipe lines replaced by new or relaid pipe, except for that portion of the old pipe removed outside the limits of excavation provided by Subarticle 214.04(a).

(b) Payment will be made under Item No.:

536-A Roadway Pipe Relaid - per linear foot {meter}
536-B Side Drain Pipe Relaid - per linear foot {meter}

SECTION 538
ROADWAY PIPE REHABILITATION

538.01 Description.

This Section shall cover the work of rehabilitating roadway pipe using a cured-in-place liner, polyethylene (PE) liner pipe, or a liner shown on the plans, at the locations shown on the plans or directed by the Engineer.

538.02 Materials.

(a) Cured-in-Place Liner.

Cured-in-Place Liner material shall be a lining system selected from List II-32 of the Department's MSDSAR.

All cured-in-place lining products shall comply with ASTM F-1216, "Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube", ASTM F-1743, "Rehabilitation of Existing Pipelines and conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)", or ASTM F-2019 "Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP), including appendices.

The liner shall be a flexible tube fabricated to a size that, when installed, shall fit the internal circumference of the existing roadway pipe. Allowance shall be made for circumferential stretching during insertion so that the final cured product is snug against the wall of the host pipe. The material shall be able to stretch to fit irregular pipe sections and negotiate bends.

Any compounds, process water or condensate used during the installation or curing operation shall be contained, removed from the site and disposed of in a manner approved by the Engineer.

(b) PE or HDPE Liner Pipe.

Polyethylene or high density polyethylene liner pipe shall be selected from List II-32 of the Department's MSDSAR.

(c) Liner Shown on the Plans.

Any liner shown on the plans may be used as an alternate to cured-in-place liner or PE liner pipe. The material requirements for alternate liners will be shown on the plans.

(d) Minimum Length of Liner.

The minimum length of liner material shall span the distance from the inlet to the outlet of the pipe, unless required otherwise by the Engineer or shown otherwise on the plans.

538.03 Construction Requirements.

(a) Submittals.

The Contractor shall submit eight copies of the product data and installation procedures of the cured-in-place liner, or PE liner pipe for review and distribution. The product data for PE liner pipe shall include actual certified test reports meeting AASHTO M 326. The submittal of the product data

and installation procedures shall be complete to the point that the physical properties of all required materials are identified and all installation procedures and containment and disposal measures are thoroughly described. An incomplete submittal will be returned to the Contractor for completion.

Polyethylene liner pipe shall be installed in accordance with the requirements given in ASTM F 585, "Insertion of Flexible Polyethylene Pipe into Existing Sewers". The Contractor shall submit these procedures and the proposed nominal pipe size as specified in AASHTO M 326 and the standard dimension ratio (SDR) of pipe required as specified in ASTM F 585.

The annular space between the PE liner pipe and the original pipe shall be shown on the submittal as being filled with a low density grout or concrete. The proposed mix design for the low density grout or concrete shall be shown on the submittal.

The submittal shall be delivered to the Project Engineer. The Project Engineer will review the submittal for completeness and then forward the submittal to the ALDOT Construction Engineer. The Construction Engineer will forward the submittal to the ALDOT Design Engineer. Work shall not begin until the submittal has been returned to the Project Engineer for distribution to ALDOT field personnel for inspection of the work.

(b) Inspection of Pipe prior to Rehabilitation.

Inspection of the pipeline shall be performed by experienced personnel trained in locating breaks, obstacles, connections, and junctions by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the liner into the pipe. Prior to installation of PE liner pipe the Contractor shall follow the inspection requirements given in ASTM F 585. A video tape and suitable log shall be submitted to the Engineer for review prior to the installation of the liner. The installation of the liner shall not begin until the Engineer informs the Contractor that the review of the inspection tape and log has been completed.

(c) Cleaning and Repairing Pipe.

The Contractor shall clean the pipeline of all obstructions that will prevent the insertion of the liner. Prior to installation of PE liner pipe the Contractor shall follow the cleaning requirements in ASTM F 585. The Contractor shall perform minor repairs to the pipe (patching spalls, sealing holes, etc.).

If the extent of obstruction and damage is severe, the Engineer may require the Contractor to uncover the pipe, remove the obstructions, and repair the pipe. Excavation and repair work will be paid for as Extra Work.

The Contractor shall not install the liner in roadway pipe sections having dropped joints or line swags without prior approval from the Engineer.

(d) Water.

The Contractor shall provide for the flow of water around the section or sections of pipe designated to be rehabilitated. Any diversion of water shall be approved by the Engineer prior to diversion.

The Contractor shall notify the local fire department and water board and obtain approval and water meter, if required, before using fire hydrants.

(e) Delivery, Storage and Handling of Materials.

The Contractor shall be responsible for delivery, storage, and handling of products. Products shall be kept safe from damage. Damaged products shall be removed from the job site promptly and shall be replaced with undamaged products.

(f) Installation Procedure.

The Contractor shall install the pipe liner in accordance with the installation procedures that have been distributed by the Engineer after being submitted by the Contractor.

The Contractor shall install the PE liner pipe in accordance with the installation procedures given in ASTM F 585. The annular space between the existing pipe and the PE liner pipe shall be filled with a low density grout or concrete.

A full protocol for time, rate of travel of the ultraviolet assembly, pressures, and amount of lamps in operation shall be maintained and submitted as documentation for the correct ultraviolet light curing of the fabric tube. The protocol shall be recorded automatically from the beginning of inflation of the liner until the end of the curing. It shall also show the basic information in a header, such as project name, address, section, and date, to clearly identify the renovated section.

(g) Sealing Pipe at Junction Box, Inlet or Headwall.

If there is not a tight seal in a junction box, inlet or headwall, the Contractor shall apply a sealant at that point by pressure injection or other means to ensure a watertight seal. The repair shall be rechecked after 48 hours to ensure that the seal is holding. If the seal does not hold, the Contractor

shall continue to apply sealant until a seal is made and there are no leaks. The Contractor shall seal the pipe without additional compensation.

(h) Inspection of Pipe after Rehabilitation.

Inspection of the pipeline shall again be performed by experienced personnel trained in the use of closed circuit television for the inspection of pipes. The interior of the pipeline shall be carefully inspected to determine if there are areas where the liner does not adhere to the pipe wall, or if there are ruptures in the lining. A video tape and suitable log shall be submitted to the Engineer for review after the installation of the liner. All repairs shall be made without additional compensation.

(i) Clean Up.

After the installation work and inspection has been completed and the work found acceptable, the Contractor shall clean up the work area. All excess material and debris not incorporated into the permanent installation shall be disposed of by the Contractor. The work area shall be left in a condition equal to or better than prior condition.

(j) Warranty.

All pipe rehabilitation work shall be warranted to be free from defects in materials and workmanship for a period of five years from the date of rehabilitation. The Contractor shall obtain a written warranty from the supplier of the cured-in-place liner system or PE liner pipe and submit it to the Engineer after the initial inspection and before installation begins. The warranty should include the statement that any defect that occurs during a five year period that is attributable to the liner installation or materials will be repaired by the supplier at no cost to the ALDOT. It should be noted in the warranty that the five year period shall begin upon final acceptance of the rehabilitated pipe.

538.04 Method of Measurement.

Roadway pipe rehabilitation will be measured in linear feet {meters} along the flowline of the rehabilitated pipe.

538.05 Basis of Payment.

(a) Unit Price Coverage.

Roadway Pipe Rehabilitation, measured as noted above, will be paid for at the contract unit price, which shall be full compensation for submittals, furnishing and installing the pipe lining, cleaning and minor repair of the pipe, the warranty and for all equipment, tools, labor and incidentals necessary to complete the work. The contract price shall also include television inspection before and after liner installation.

(b) Payment will be made under Item No.:

538-A ____ inch {mm} Roadway Pipe Rehabilitation - per linear foot {meter}
538-B _____ inch {mm} Span, _____ inch {mm} Rise Roadway Pipe Rehabilitation - per linear foot {meter}

SECTION 539
TRENCH DRAINS

539.01 Description.

This Section shall cover the work of constructing trench drains. The drains shall be of cast-in-place concrete drains or prefabricated drainage channels encased in cast-in-place concrete. The drains shall be constructed to form a channel for the collection and flow of stormwater. Grates shall be installed to allow water to pass into the channel and to allow vehicular traffic to move over the drains.

539.02 Materials.

(a) Drain Channel.

The minimum width and depth of the drain channel below the drain grate will be shown on the plans. The drain channel shall have a rounded bottom. Connections to structures shall not restrict the hydraulic flow of the drain channel.

(b) Drain Channel Roughness Coefficient.

The drain channel shall have a smooth interior face. The roughness coefficient for the interior face of a prefabricated drain channel shall not be greater than 0.010. The interior face of a cast-in-place drainage channel shall have a Class 2 surface finish in accordance with the requirements given in Section 501.

(c) Concrete.

The concrete shall be Class A concrete in accordance with the requirements given in Section 501.

The minimum amount of concrete around the drain channel will be shown on the plans. Concrete shall be placed in a monolithic pour between inlet structures.

Construction joints will only be allowed if approved by the Engineer. If joints are allowed they shall be constructed with a waterstop and a concrete lug or keyway approved by the Engineer.

(d) Grates and Frames.

The grates, and the frames for supporting the grates, shall be made from ductile iron conforming to ASTM A 536, Grade 65-45-12 or cast iron conforming to ASTM A 48 Class 38B.

The opening in the grate shall be a minimum of 60% of the open area at the top of the drain except where ADA regulations apply as shown on the plans.

The Contractor shall submit results from an independent laboratory verifying that the grates meet the requirements given in AASHTO M 306, for "Proof Load Testing".

Grate retaining devices shall not obstruct the flow of water into the channel or through the channel.

A grate shall fit into the frame without rocking. It shall be held in place by stainless steel tamper resistant locking devices.

The Contractor shall submit results from an independent laboratory verifying that the grates will withstand a minimum repetitive pullout resistance of 200 pounds per foot {5 kN per meter} after the completion of 1,000 hours of salt spray in conformance with ASTM B 117. The grate retaining device shall withstand, without maintenance, cyclic vertical loads of 500 pounds {2.2 kN}.

Frames shall be independent of the channel and shall be anchored into the surrounding concrete by metal extensions attached to the frame at all four corners.

Rails that are cast into the concrete shall be ASTM A 36 structural steel, post fabrication galvanized per ASTM A 123.

(e) Prefabricated Drain Channel.

Prefabricated drain channels shall be made from components that are anchored by the placement of concrete to encase the anchoring lugs that are integral to the channel components.

The physical properties of the prefabricated drain channel shall be compatible with the physical properties of the concrete. The thermal coefficient of expansion shall be similar to that of the concrete so that separation does not occur between the prefabricated drain channel and the encasement concrete.

Prefabricated drain channels shall interlock with adjoining channels.

539.03 Construction Requirements.

(a) General.

The Contractor shall submit the trench drain manufacturer’s recommendations for installation to the Engineer prior to beginning installation. This submittal shall include a quantity listing of all materials required for the construction of the trench drain. The submittal shall be delivered to the Engineer at least ten calendar days prior to beginning the construction of the trench drain. The Contractor shall resubmit the trench drain data if the submittal is determined to be inadequate. Construction shall not begin until the submittal is complete.

A representative of the trench drain manufacturer shall be present to advise the Engineer of the adequacy of the first trench drain units that are installed. The installation of the trench drain units shall not begin until the manufacturer's representative is present at the site of installation.

Connection to an existing structure may require the use of a transitional fitting and/or sections of pipe to provide a suitable connection without damage to the grate, drain and structure. Connections to structures shall be approved by the Engineer prior to construction.

When the trench drain begins or terminates without a connection to other pipes or drainage structures, the trench drain end shall be sealed or plugged with a suitable cap as shown on the plans. The seal shall provide a waterproof connection.

(b) Trench Excavation.

Excavation shall be kept as nearly as possible to the minimum width, depth, and length shown on the plans.

(c) Drain Placement and Protection.

Precast drains shall be installed to the lines and grades shown on the plans or as directed by the Engineer.

The trench slot shall be protected during installation by a removable wood strip, heavy duty tape, or other suitable material, affixed to the slot to prevent infiltration of material into the drain. After finishing the surface, the protective covering shall be removed and any debris that entered the trench shall be removed.

(c) Concrete Placement.

The furnishing and placement of the concrete shall be in accordance with the requirements given in Section 501.

The prefabricated trench drain components shall be supported or held in place in such a manner as to permit flow of the concrete backfill material around the drain.

The concrete encasement adjacent and beneath the drain channel shall be a minimum thickness of 6 inches (150 mm}. Drain channels shall be positioned in the excavated trench so that, when finished, the surrounding concrete backfill will encase the channel.

Concrete backfill shall be placed in the trench against undisturbed material at the sides and bottom of the trench and in a manner that will prevent floating or shifting of the trench drain components and voids in, or segregation of, the concrete. Where necessary, earth plugs shall be constructed and compacted at the ends of the planned concrete backfill to contain the concrete within the trench.

Concrete shall be finished flush with adjacent surfacing. The surface of the concrete shall be textured with a broom or burlap drag to produce a durable skid-resistant surface.

Under no circumstances shall any portion of the trench drain slot extend above the paving material or curb and gutter section.

539.04 Method of Measurement.

The trench drain will be measured in linear feet {meters} along the top of the drain. Connections to other structures (i.e. elbows, pipe, joints, etc.) will not be measured for payment unless shown otherwise on the plans. Excavation and backfill will not be measured for payment.

539.05 Basis of Payment.

(a) Unit Price Coverage.

Trench Drain will be paid for at the contract unit price, which shall be full compensation for fabricating, furnishing and installing the trench drain components. It shall also be full compensation for furnishing and installing connections to other structures, for all concrete, excavation, backfill, satisfactory disposal of surplus materials, and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

539-A ___ inch {mm} Trench Drain - per linear foot {meter}

SECTION 546
MICROPILES

546.01 Description.

This Section shall cover the work of constructing, furnishing, and installing micropiles as shown on the contract plans, approved working drawings, and as specified herein. The Contractor shall be responsible for furnishing all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for design, installation, and testing of micropiles and top attachments.

The Contractor shall select micropile type, size, micropile top attachment, and construction methods. The Contractor shall estimate the ground to grout bond value and determine the required

bond length. The Contractor shall install a system that will provide the load capacities shown in the working drawings.

546.02 Materials.

(a) General.

Handling, storage, and control of materials shall comply with appropriate portions of Section 106. All materials shall conform to the requirements set forth in Division 800, Materials. Specific reference is made to applicable portions of the Specifications:

Section 802 – Fine Aggregate
Article 807.01 – Water

(b) Cement.

Cement shall be Type I, Type II, or Type IL and shall meet the requirements of Section 815.

(c) Steel Reinforcement.

Reinforcing steel shall be Grade 75, and shall meet the requirements given in AASHTO M31 and Section 835. Bars shall be threaded a minimum of six inches or continuous spiral deformed bars designed for coupling. Bar couplers, if required shall develop the ultimate tensile strength of the bars without any evidence of failure.

(d) Pipe/Casings.

Permanent steel casting/pipe shall meet the tensile requirements of American Petroleum Institute (API) N80 as used in the design submittal, having the diameter and minimum wall thickness shown in the working drawings. Micropile casing shall be smooth, non-corrugated, clean, watertight steel, and threaded to develop the required design strength of the casing section. Welded splices will not be allowed. Casings shall be new the use of used casings will not be allowed.

The Contractor shall provide documentation stating the origin in accordance with the requirements given in Subarticle 106.01(a), pipe description, and quantity of pipe/casing delivered to the project. Additionally, the Contractor shall submit a minimum of two representative coupon tests from an independent testing laboratory or mill certifications, for each load of pipe/casing delivered for use on the project.

(e) Plates and Shapes.

Structural steel plates and shapes for micropile top attachments shall conform to ASTM A36 or ASTM A572 Grade 50 and Section 836.

(f) Centralizers.

Centralizers shall be installed to align the reinforcing bars in the micropile. Centralizers shall be manufactured from Schedule 40 PVC pipe, steel or other material that will not be detrimental to the performance of the micropile. The use of wood centralizers will not be allowed. Centralizers shall have a means for being securely attached to the reinforcing bar. The centralizers shall be sized to position the reinforcing bar within 1 inch of the center of the micropile to allow tremie pipe insertion to the bottom of the micropile and to allow free flow of grout.

(g) Grout.

The grout shall be a neat cement or sand/cement grout. The Contractor shall submit the proposed grout mix design to the Materials and Tests Engineer for approval no later than 30 calendar days prior to production. The Contractor shall make arrangements for an ALDOT approved testing laboratory to test the proposed grout mix design. The mix design shall include the following:

1. A list of all the materials used in the design of the mix with the source and vendor code indicated.
2. Compressive strength test results verifying that the proposed mix design will have a minimum compressive strength of 2000 psi at 3 days, and a minimum compressive strength of 4000 psi at 28 days. Compressive strength shall be tested in accordance with the requirements given in AASHTO T 106, "Compressive Strength of Hydraulic Cement Mortar (Using 50 mm or 2 inch Specimens)".

Test results for the proposed grout mix that have been completed within one year of the start of work, and that have been performed by an ALDOT approved testing laboratory, may be submitted for verification of the mix design.

546.03 Micropile Design and Submittals

(a) Contractor Qualifications.

The micropile Contractor shall be experienced in the design, construction, and load testing of micropiles and have at least five years of experience and constructed at least three projects of similar size and capacity to those required by this project.

The Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions. The Contractor shall submit construction details, structural details and load test results for at least three previous successful micropile load tests from different projects of similar scope to this project.

The Contractor shall assign a supervising project manager with experience on at least three projects of similar scope to this project completed over the past five years to supervise the work performed. The Contractor shall not use consultants or manufacturers' representatives to satisfy the supervising manager requirements of this Section. The on-site foremen and drill rig operators shall also have experience on at least three projects over the past five years installing micropiles/pre-bored pile retaining wall structures.

(b) Micropile Design.

The micropiles shall be designed in accordance with the guidelines given in FHWA NHI-05-039 "Micropile Design and Construction Reference Manual", by a Professional Engineer licensed in the State of Alabama, with experience in the design of at least three successfully completed micropile projects over the past five years.

The overall length of a micropile will be selected such that the required capacity is developed by skin friction between grout and rock socket over a suitable continuous length in competent rock. A factor of safety of 2.0 shall be used when calculating the allowable geotechnical capacity of the bond zone.

The micropile top attachment shall effectively distribute the design load to the concrete footing such that the concrete bearing stress does not exceed American Concrete Institute (ACI) Building Code and the bending stress in the steel plates does not exceed American Institute of Steel Construction (AISC) allowable stresses for steel members.

The geotechnical capacity shall not rely on bond from clay soils or fractured weathered rock layers, intermittent rock layers with clay seams, rock underlain by voids or boulders above the competent rock.

The Contractor may independently conduct any geotechnical investigation necessary to provide a proper design and installation of the system. Any additional investigation needed during construction to define foundation conditions will be at no additional cost to the Department.

If a manmade obstruction is encountered during installation of a micropile that prevents the advancing of the micropile; the micropile shall be abandoned and filled with grout. The Contractor and ALDOT shall determine an acceptable alternative plan. Contractor shall be paid for abandoned holes that are due to no fault of the Contractor.

(c) Submittal of Micropile Design, Details, and Installation Plan

1. Completed Project Reference and Personnel Lists

At least 30 calendar days before the planned start of micropile construction, the Contractor shall submit 5 copies of the completed project reference list and a personnel list. The project reference list shall include a brief project description with the owner's name and current phone number and load test reports. The personnel list shall identify the micropile system design engineer (if applicable), supervising project engineer, drill rig operators, and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals shall be borne by the Contractor.

Work shall not be started, nor materials ordered, until the Engineer's written approval of the Contractor's experience qualifications is given. The Engineer may suspend the work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

2. Working Drawings

The Contractor shall submit working drawings and relevant structural design calculations for the micropile system to the Bridge Engineer for review prior to the start of any work. A Registered Professional Engineer in the State of Alabama shall stamp the submittal. The following information shall be included with the working drawings and design calculations submittal(s):

- A written summary report which describes the overall micropile design.
- Micropile details for each micropile type (load) showing:
  - Micropile design load.
  - Elevation view showing type and size of permanent casing and reinforcing steel,
  - Minimum total bond length
  - Total micropile length.
  - Micropile top attachment.
- Micropile numbering system for records.
- Grouting plan and grout mix designs, including:
  - Procedure for placing the grout, and methods for accurately monitoring and recording the grout depth and grout volume.
  - The Contractor shall clearly identify the minimum specified grout compressive strength at which load tests shall be performed.
  - Estimated curing time for grout to achieve specified strength.
  - Procedure and equipment for Contractor's monitoring of grout quality and volume installed.
- Detailed, step-by-step description of the construction procedure and sequence, including personnel and a quality control plan. This step-by-step procedure shall be shown on the working drawings in sufficient detail to allow monitoring of the construction and quality of the micropiles.
- Information on headroom and space requirements for installation equipment that verify that the proposed equipment can perform at the site.
- Details for plumb hole drilling.
- Details for centralizers.
- Pipe and reinforcement splice type and locations.
- Details of the load testing apparatus for verification and proof loading tests.
- Calibration documentation of the hydraulic jack(s) to be used for load testing.
- Details for exploratory drilling of micropiles with rock sockets

The Engineer will review the design calculations, working drawings, and material requirements, and construction procedure for conformance to the plans and specifications. The Engineer will not approve these parts of the submittal but will review them to ensure that they are sufficiently complete to allow the construction of the micropiles.

The Engineer will return the submittal for corrections, distribute the submittal for construction inspection, or contact the Contractor to establish a mutually agreeable date and time for a meeting to discuss the submittal. The Contractor will be notified of changes in the submittal deemed necessary within seven days after the meeting. Micropile construction shall not begin until the submittal has been distributed for construction inspection and the Engineer informs the Contractor in writing that the proposed working drawings, design calculations, material requirements, and micropile construction procedure are complete. Distribution of the submittal for construction inspection shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed on the plans and in the specifications.

Any proposed modification of the construction procedure during construction shall be submitted to the Bridge Engineer for review and distribution.

(d) Construction Site Survey.

The Contractor shall review the available subsurface information and visit the site to assess the site conditions, equipment access conditions, and location of the existing structures and above ground facilities.

The Contractor is responsible for field locating and verifying the location of all utilities shown on the plans prior to beginning any work. The Contractor shall not interrupt any existing utility services unless authorized in writing. The Contractor shall notify the appropriate parties of any utility locations different from those on the provided plans that may require modification to the micropile locations or design modifications.

(e) Pre-Construction Meeting.

A pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction. The Engineer, Geotechnical Engineer, Area Materials Engineer, Bridge Engineer, Construction Engineer, prime Contractor, micropile specialty Contractor, micropile design engineer, excavation Contractor and geotechnical instrumentation specialist (if applicable) shall attend the meeting. Attendance is mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the prime Contractor and the various Subcontractors—specifically those pertaining to excavation for micropile structures, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control and site drainage control.

546.04 Construction Requirements.

(a) Installation.

The contractor shall install the micropile using core drilling, rotary drilling, percussion drilling, auger drilling, driven casing or other acceptable means unless otherwise directed. Micropiles can be installed in the drilled hole after drilling or can be advanced by the drill.

1. Exploratory Drilling of Micropiles with Rock Sockets

When the micropiles design capacity is developed from a rock socket, the contractor shall perform exploratory drilling or probing to determine the location, extent, and quality of the rock in which the socket will be constructed. A minimum of 30% of the micropile locations in each footing shall be drilled or probed. The drilling/probing locations shall be selected such that three (3) subsurface profiles are generated transverse to the long dimension of the footing and two (2) subsurface profiles are generated transverse to the short dimension of the footing. The drilling or probing shall extend into competent rock a minimum of 1.5 times the length of the proposed micropile design rock socket. Production micropile drilling and installation for a given footing shall not begin until the results of this exploration are submitted and approved by the Engineer. This submittal shall include the following:

- A plan view showing all micropiles in the footing with corresponding micropile numbers and locations of exploratory borings.
- Drill logs indicating the existing ground elevation at the time of drilling, micropile number, bottom of footing elevation, elevations of soil and rock layers, estimate of rock quality, and proposed micropile tip elevations.

Subsurface information contained in the contract plans may be used in lieu of exploratory drilling for individual micropiles with prior approval of the Materials and Tests Engineer.

2. Drilling and Grouting

All foreign material dislodged or drawn into the hole during construction of the micropiles shall be removed.

Centralizers shall be used when installing central bar reinforcement. The contractor shall allow free flow of the grout and provide a positive means of support for maintaining the position of the casing and reinforcement until the grout has set. Reinforcement shall be lowered in the stabilized hole. Reinforcement shall not be forced or driven into the hole.

The Contractor shall dispose of cuttings, construction debris, and spilled or wasted grout in accordance with the Plans and federal, state and local laws.

The grout shall be mixed to produce a uniform mixture free of lumps and undispersed cement. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. Provide a pressure gauge capable of measuring pressure of at least 150 psi or twice the actual grout pressures used, whichever is greater. Use grouting equipment capable of pumping the grout in one continuous operation. Continuously agitate the mixed grout during pumping operations.

The grout shall be injected from the lowest point of the drilled borehole and filled without voids to the top of the micropile. The grout may be pumped through grout tubes, casing, hollow-stem-augers or drill rods.

The quantity of the grout and the grout pressures shall be recorded. The contractor shall control the grout pressures to prevent excessive heave but shall fill the entire micropile with grout. Grout test specimens shall be made on production grout to ensure that the grout meets the requirements of Subarticle 546.02(g). The grout test specimens shall be molded and tested in accordance with the requirements given in AASHTO T 106. The Contractor's testing technicians shall clearly label each grout cube test specimen and identify the micropiles associated/represented by each set of specimens. A set of tests specimens is comprised of three grout cubes. The requirements for grout testing are as follows:

a. Batch Grouting

If small batch grouting operations are used a minimum of three sets of grout test specimens shall be created for each batch of micropile grout produced. One set of test specimens shall be designated for three-day compressive strength testing and one set shall be designated for 28-day compressive strength testing. One set of test specimens shall be given to the Engineer for transport to the Department Laboratory for verification testing.

b. Continuous Grouting

If continuous grouting operations are used a minimum of three sets of grout test specimens shall be created for every 30 cubic yards or portion thereof of mircopile grout produced One set of test specimens shall be designated for three-day compressive strength testing and one set shall be designated for 28-day compressive strength testing. One set of test specimens shall be given to the Engineer for transport to the Department Laboratory for verification testing.

The Department will perform random verification testing for 28-day compressive strength on a frequency of one test for every 5 batches for batch grouting operations or one test for every 150 cubic yards or fraction thereof for continuous grouting operations. The test verification sample will be selected as outlined in ALDOT-210 "Selecting Samples By The Random Numbers Method". The Department will test the remaining four samples in the event of a low break.

(b) Installation and Post Construction Records.

The Contractor shall maintain an independent record of all field installation activities. An ALDOT Representative shall also maintain an independent record of all field installation activities. At the end of each day; the Contractor and the ALDOT Representative shall reconcile and agree upon the quantities installed. A log for each micropile shall be created and signed by a representative of the Contractor and ALDOT. The micropile records shall be submitted to the Project Manager within 48 hours after installation is completed for each micropile. The records shall include the following information:

- Micropile drilling duration.
- Final tip elevation.
- Total micropile length.
- Description of unusual installation behavior or conditions.
- Grout quantities pumped.
- Grout test specimen compressive strength results.
- Micropile materials and dimensions.

Post construction records shall be submitted to the Project Manager within 30 calendar days after completion of work and shall include the following:

- As-built drawing showing locations of the micropiles and length.
- Detailed drilling records.
- Grouting records indicating the cement type and quantity injected.

(c) Performance and Testing.

The Contractor shall perform both load capacity verification testing prior to the installation of production micropiles and proof load testing of designated production micropiles. Proof load tests shall be performed on production micropiles at locations selected by the Project Manager. No load tests shall be performed before the grout has reached the minimum specified compressive strength. All load tests shall be performed with a jack calibrated in accordance with ALDOT-358 and Subitem 505.03(g)1d.

1. Verification Testing of Test Pile.

The contractor shall install a minimum of one (1) non-production test pile for performance verification load testing outside of the proposed footing at the location shown on the plans or

as designated by the Engineer. The test pile shall not be a production pile. The test pile shall be loaded to 200 percent the design load and evaluate the ultimate pile capacity to insure compliance with job performance requirements. The Contractor shall notify the Engineer one week before installing test micropile groups that are to be performance tested. No micropile, test pile or production piles shall be load tested until three days after grouting operations are complete.

Load tests shall be performed in accordance with ASTM D1143, "Standard Test Methods for Deep Foundations Under Static Axial Compressive Load", using Procedure A – Quick Test.

The axial compressive load shall be applied with a calibrated hydraulic jack. Apply the test load in increments of 5% of the anticipated failure load to maximum of a 200 percent of the foundation load shown on the Bridge Layout. Add load increments until reaching a failure load, but do not exceed the maximum testing load (200% of the foundation load). During each load interval, maintain load increments for 5 min and record test readings taken at 0.5, 1, 2 and 4 min after completing the application of each load increment. Use the same time interval for all loading increments through the test. Creep tests shall be performed at the test interval equal to 130 percent of the design load. Remove the load in six approximately equal increments. Keep the load constant for 5 min using the same time intervals for all unloading decrements. Record test readings taken at 1 and 4 min after completing each load decrements. Take and record readings at 1, 4, 8 and 15 min after removing all loads. Refer to a constant elevation benchmark for readings of settlements and rebounds. Record them to 0.01 in. for each increment or decrement of load.

Test piles will be considered acceptable if results meet the following criteria:

- No failure occurs.
- The ultimate pile capacity from the load test is not less than 200 percent of its design load.
- The measured total pile head movement for the required load hold at 130 percent of the design load does not exceed 0.04 inches between one and five minutes, the micropile shall be considered acceptable with respect to creep. For verification load tests where the measured total movement exceeds this criteria, the load shall be held for an additional 55 minutes. If the measured total movement over this additional time period does not exceed 0.08 inches between six and 60 minutes, the micropile shall be considered acceptable with respect to creep.

If the test pile fails, the contractor shall modify the design and/or the construction procedure and install and test another pile at no additional expense to the Department. Any design modifications that require changes to the micropile type or to the structure shall be submitted in writing to the Bridge Engineer for review and acceptance. Any micropile production price increases due to design modifications and/or changes in the construction procedure shall be incurred by the Contractor.

2. Proof Load Testing of Production Micropiles.

Load capacity proof load testing shall be performed on production micropiles to ensure that the Contractor's construction procedure has remained constant and that the micropiles have not been placed in a soil zone not represented by the test pile verification testing.

Proof load testing shall be performed on a minimum of five percent (1 in 20) of the production micropiles with a minimum of one proof load test per footing. The Engineer will randomly select the micropile locations for testing as outlined in ALDOT-210.

Proof load test shall be performed as described in Item 546.04(c)1. except that micropiles shall be tested to a maximum load of 130 percent of the design load and the test shall be performed in accordance with the requirements given in ASTM D3689, "Standard Test Methods for Deep Foundations Under Static Axial Tensile Load", using Procedure A – Quick Test.

A test pile that acceptably passes the verification test shall not be considered equivalent to a proof load test micropile and shall not be used in determining the number required proof load tests.

Proof load tests shall be considered acceptable if results meet the following criteria:

- No pull out failure occurs at or before the maximum load. Pullout failure is defined as the load at which attempts to further increase the test load result in continued pullout movement of the micropile.

- The measured total pile head movement for the required load hold at 130 percent of the design load does not exceed 0.04 inches between one and five minutes, the micropile shall be considered acceptable with respect to creep. For verification load tests where the measured total movement exceeds this criteria, the load shall be held for an additional 55 minutes. If the measured total movement over this additional time period does not exceed 0.08 inches between six and sixty minutes, the micropile shall be considered acceptable with respect to creep.

If a proof load test on a production pile fails, the Contractor will be directed to proof test another nearby micropile. The failed micropile test will not be considered for the minimum five percent requirement for proof load testing of production micropiles. For failed micropiles and further construction of other micropiles, the Contractor shall modify the design, the construction procedure, or both. Modifications may include installing replacement micropiles, incorporating additional micropiles of reduced load capacities, modifying installation methods, increasing the bond length, or changing the micropile type. Any design modifications that require changes the micropile type or to the structure shall be submitted in writing to the Bridge Engineer for review and acceptance. Any micropile production price increases due to design modifications and/or changes in the construction procedure shall be incurred by the Contractor.

3. Allowable Tolerances.

- Centerline of piling shall not be more than two inches from the indicated plan position.
- Micropile alignment shall be within two percent of design alignment.
- Top elevation of micropile shall be within two inches of the design elevation.
- Centerline of reinforcing steel shall not be more than 0.75 inches from the indicated horizontal location.
- The length of micropiles/depth of the socket shall not exceed 20 percent of the design length without written approval from the Engineer. Failure to obtain written approval may result in the rejection of the micropile.

546.05 Method of Measurement.

(a) Micropiles.

Measurement will be made as follows for the quantity, as specified or directed by the Engineer: Micropiles will be measured in linear feet, installed, and accepted. The accepted length of micropiles will be no more than 20 percent of the design length without written approval from the Engineer.

(b) Verification Load Test Pile.

The verification test micropile installed as directed by the plans and these Specifications, will be measured complete and in place. The Verification test micropile will not be included in the measurement of the linear feet of production piles. No measurement or direct payment will be made for test pile cut-offs. Verification test micropiles will be measured per each.

(c) Proof Load Testing.

Micropile Proof Load Tests will be measured per each.

546.06 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price paid for micropile includes full compensation for designing and furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing micropiles, including casings, grout, reinforcement, cutting tips, drill bits, pile anchorage, and disposing of materials resulting from pile installation, complete in place, as shown on the plans, as specified in this specification and as directed by the Engineer.

No payment will be made for micropiles that are damaged either during installation or after the micropiles are complete in place. No payment will be made for additional excavation, backfill, concrete, reinforcement, nor other costs incurred from footing enlargement resulting from replacing rejected micropiles. No payment will be made for micropile lengths longer than the accepted micropile length unless written approval is obtained prior to the installation of the micropile.

The contract unit price paid for micropile verification load test shall be full compensation for all labor, materials, equipment, devices, submittals, and incidentals necessary to perform the

required tests and submit the test results and shall be full compensation for site restoration after the test.

(b) Payment will be made under Item No.:

546–A Micropiles – per linear foot
546–B Micropile Verification Load Test Pile – per each
546–C Micropile Proof Load Test – Per each

SECTION 570
SOIL NAIL RETAINING WALL

570.01 Description.

This work shall consist of designing and constructing soil nail retaining walls at the locations shown on the Plans. The work shall include excavating in staged lifts in accordance with the approved Contractor's plan; drilling and installation of the soil nails to the diameter and length required to develop the specified capacity; grouting the nails; providing and installing the specified drainage features; providing and installing bearing plates, washers, nuts, and other required miscellaneous materials; and constructing the temporary shotcrete face if required and constructing the final structural facing. The Contractor shall select the excavation, drilling, and grouting methods and the diameter of the drill holes to meet the performance requirements specified herein or as shown on the plans.

Soil nail walls used for temporary shoring and which will have a service life less than 18 months may be designed with the less design stringent criteria outlined in Section 570.09 below.

The requirements for the construction of shotcrete facing for the wall are given in Section 571.

570.02 Materials.

(a) Steel Bars for Soil Nails.

The steel bars shall be straight, solid or hollow core and continuous (without splices). The bars shall conform to the requirements given in AASHTO M 31, for Grade 60 or 75, or the requirements given in ASTM A 722 for Grade 150.

The bars shall be either deformed bars (deformations for the anchorage coupling), reinforcing bars that are threaded at the end for the anchorage coupling or continuous spiral deformed bars.

Bars shall be threaded a minimum of 6 inches at the wall anchorage to allow proper attachment of a bearing plate and nut. The threading for the anchorage may also be the continuous spiral deformed ribbing of bar deformations designed for coupling, or threads that are cut into a reinforcing bar. If threads are cut into a reinforcing bar, the threaded portion of the bar shall be 6 inches long and the Contractor shall install the next larger sized bar above the size of the required bar. Larger bars shall be furnished without extra compensation.

(b) Coating and Encapsulation of Steel Bars for Soil Nails.

1. Coating.

If epoxy coating is shown to be required on the plans, the bars shall be coated by fusion bonded (electrostatically applied) epoxy coating in accordance with the requirements given in ASTM A 775 with the exception that the minimum thickness of coating shall be 0.012 inches. Bend tests will not be required. All other test results shall be furnished to the Engineer before the Engineer will allow the installation of the bars. Coating will not be required over the threaded end at the wall anchorage.

The Contractor shall handle and store epoxy coated bars in a way that will prevent them from being damaged beyond what is permitted by ASTM D 3963. The Contractor shall repair damaged epoxy coating in accordance with the requirements given in ASTM A 775 and the coater's recommendations using an epoxy field repair kit recommended by the epoxy manufacturer. All repaired areas shall have a minimum 0.012 inch coating thickness.

2. Encapsulation.

The steel bars shall be encapsulated if this is shown to be required on the Plans. The encapsulation shall be a sheath that is composed of grout injected into a tube surrounding the bar.

The tube shall be corrugated HDPE tube conforming to the requirements given in AASHTO M 252 for Type C or shall be corrugated PVC tube conforming to ASTM D 1784, Class 13464-B. The wall of the plastic tube shall be a minimum 0.04 inches thick. A minimum of 0.2 inches of grout cover shall be placed over the epoxy coated bar within the plastic tube.

Encapsulated bars shall not be moved or transported until the encapsulation grout has reached a compressive strength of at least 1500 psi but not before 24 hours. The Contractor shall replace damaged encapsulated bars.

3. Sampling of Bars.

The Contractor shall arrange for the Engineer to select a sample of one bar of each diameter bar for testing after epoxy coating or after encapsulation if encapsulation is required.

(c) Sacrificial Steel Loss.

If epoxy coating and/or encapsulation are not shown as required in the Plans, the soil nail bars shall be designed for sacrificial steel loss. The following procedure shall be used to calculate the effective bar properties for design:

1. Obtain the values of cross sectional area, A_c, nominal (average) inner diameter, d_i, nominal yield strength, F_Y, and nominal ultimate strength, F_U, from the manufacturer's data.
2. Calculate the outer diameter, d_o, as $d_o = [(4A_c/\pi) + (d_i^2)]^{0.5}$
3. Reduce the value of d_o by the 0.315 inches. Call this the effective diameter d_{eff}.
4. Calculate the effective area, A_{ceff}, by using d_{eff} instead of d_o as $A_{ceff} = (\pi/4)(d_{eff}^2 - d_i^2)$
5. Calculate the effective section modulus, S_{eff}, and the effective moment of inertia, I_{eff}, for the
6. reduced section as follows: $S_{eff} = [(\pi/32)(d_{eff}^4 - d_i^4)]/d_{eff}$; $I_{eff} = (\pi/64)(d_{eff}^4 - d_i^4)$
7. Calculate the effective nominal yield strength, F_{Yeff}, and effective nominal ultimate strength, F_{Ueff}, as follows: $F_{Yeff} = F_Y (A_{ceff}/A_c)$; $F_{Ueff} = F_U (A_{ceff}/A_c)$

The reduction in steel thickness shall also be taken into account for the couplers and nuts.

(d) Bearing Plates, Welded Shear Stud Connectors, Nuts and Washers for Anchorage of Soil Nails.

Bearing plates, nuts and washers shall conform to the requirements given in Section 836. Bearing plates shall be galvanized according to the requirements given in AASHTO M 111 for Grade 85. Nuts and washers shall be galvanized according to the requirements given in AASHTO M 232 for Class C.

Welded shear stud connectors shall be one of those shown in List II-4 of the ALDOT manual "MATERIALS, SOURCES, AND OTHER DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS". Studs shall be attached in accordance with the requirements given in ANSI/AASHTO/AWS D1.5/D1.5M 2008 Bridge Welding Code and Article 836.46. Welded shear studs shall be galvanized according to the requirements given in AASHTO M 111 for Grade 85.

(e) Welded Wire Steel Reinforcement for the Shotcrete Wall Face.

The welded wire reinforcement shall be the dimensions and wire thickness as shown in the contractor final design drawings and in conformance with the requirements given in Article 835.03. The welded wire mesh shall be galvanized according to the requirements given in AASHTO M 111 for Grade 85.

(f) Centralizers for Alignment of Soil Nail.

Centralizers shall be installed to align the soil nail in the hole drilled in the soil. Centralizers shall be manufactured from Schedule 40 PVC pipe, steel or other material that will not be detrimental to the performance of the soil nail (wood shall not be used). Centralizers shall have a means for being securely attached to the soil nail. The centralizers shall be sized to position the nail bar within 1 inch of the center of the drill hole to allow tremie pipe insertion to the bottom of the drill hole and to allow grout to freely flow up the drill hole.

(g) Grout.

The grout shall be a neat cement or sand/cement grout. The Contractor shall submit the proposed grout mix design to the Materials and Tests Engineer for approval no later than 30 calendar days prior to production. The Contractor shall make arrangements for an ALDOT approved testing laboratory to test the proposed grout mix design. The mix design shall include the following:

1. A list of all the materials used in the design of the mix with the source and vendor code indicated.
2. Compressive strength test results verifying that the proposed mix design will have a minimum compressive strength of 1500 psi at 3 days, and a minimum compressive

strength of 3000 psi at 28 days. Compressive strength shall be tested in accordance with the requirements given in AASHTO T 106, "*Compressive Strength of Hydraulic Cement Mortar (Using 50 mm or 2 inch Specimens)*".

Test results for the proposed grout mix that have been completed within one year of the start of work, and that have been performed by an ALDOT approved testing laboratory, may be submitted for verification of the mix design.

(h) Shotcrete.

Shotcrete shall meet the requirements given in Section 571.

(i) Cement.

Cement shall be meet the requirements given in Section 815 and shall be either Type I or III.

(j) Film Protection for Overnight Exposure.

Sheet materials for overnight exposure protection shall be waterproof material and/or polyethylene film conforming to the requirements given in AASHTO M 171.

(k) Drainage Materials.

1. Geocomposite Sheet Drain.

Geocomposite Sheet Drain shall be manufactured with a drainage core and a drainage geotextile encapsulating the core such as Mirafi G100N, SiteDrain Sheet 184, or an approved equal. The drainage core shall be manufactured from long chain synthetic polymers composed of at least 85 % by weight of polypropylenes, polyester, polyamine, polyvinyl chloride, polyolefin, or polystyrene and shall have a minimum compressive strength of 40 psi when tested in accordance with ASTM D 1621 Procedure A. The geotextile shall have a minimum flow rate of .08 gallons per second per foot of width when tested in accordance with the requirements given in ASTM D 4716. The test conditions shall be an applied load of 10 psi at a gradient of 1.0 after a 100 hour seating period.

The Contractor shall furnish manufacturer's certified test reports for the geocomposite sheet drain. The test results shall include quantity of material represented by the tests. The material tested shall be taken from the actual production run of material that is furnished for installation. The lot size shall be equivalent to the total amount of drainage mat required for each retaining wall on the project.

2. Underdrain Outlet Pipe.

Underdrain and drainage outlet pipe shall meet the requirements given in Section 606.

570.03 Soil Nail Wall Design Requirements.

The soil nail walls shall be designed using the Service Load Design (SLD) procedures contained in the Federal Highway Administration (FHWA) publication “Geotechnical Engineering Circular No. 7, Soil Nail Walls”, Report No. FHWA-NHI-14-007. The required partial safety factors, allowable strength factors and minimum global stability soil factors of safety shall be in accordance with the guidelines given in the FHWA manual, unless specified otherwise by the Engineer. Soil nail corrosion protection requirements, known utility locations, easements, and right of way will be as shown in the plans. Structural design of any individual wall elements not covered in the FHWA manual shall be by the service load or load factor design methods in conformance with "Combinations of Loads" and other appropriate articles of the 17th Edition of the AASHTO Standard Specifications for Highway Bridges including current interim specifications.

The Contractor shall be fully responsible for all assumptions made about the strength of the soil and rock and all implications that the properties of the soil and rock have on the design, constructability and stability of the wall.

In accordance with FHWA Geotechnical Engineering Circular No. 7, for design with permanent applications, no more than 56% of the nail’s yield capacity (less any calculated sacrificial steel loss) shall be used.

570.04 Soil Nail Wall Design and Drawing Submittal.

(a) Initial Submittal of Design Calculations and Construction Drawings.

The Contractor shall submit 3 sets of design calculations and Wall Construction Drawings to the State Construction Engineer as an initial submittal. The initial submittal shall also identify the soil nail contractor, the on-site supervisors, and the drill operators and include the experience requirements given in Article 570.05 and Item 570.06(h)3. Changes in personnel will not be permitted without a

written request by the Contractor. This submittal should be made within 14 calendar days after the date of the "Notice to Proceed".

If clarifications are required, one set will be returned to the Contractor with comments for clarification. The initial submittal will be returned to the Contractor for clarification within 21 calendar days after the receipt of the initial submittal.

The Contractor will be allowed 7 calendar days for each clarification of the initial submittal and the Engineer will be allowed 7 calendar days to determine if further clarification is necessary.

The Engineer will not approve the submittal of design calculations and Wall Construction Drawings but will review the submittal for completeness.

The initial submittal of the design calculations and Wall Construction Drawings shall be sealed by a Licensed Professional Engineer licensed in the State of Alabama, but not employed by the Department.

(b) Final Submittal of Design Calculations and Wall Construction Drawings.

When the Materials and Tests Engineer informs the Contractor that the design calculations and Wall Construction Drawings are complete, the Contractor shall submit 5 sets of calculations and drawings, a Mylar sepia set of the drawings and an electronic file in Adobe Acrobat format of the drawings as a final submittal. The Contractor will be allowed 5 calendar days to make the final submittal.

The Contractor shall not begin wall construction or incorporate materials into the work until the Materials and Tests Engineer returns one set of the completed design calculations and Wall Construction Drawings to the Contractor.

The final submittal of the design calculations and Wall Construction Drawings shall be sealed by a Licensed Professional Engineer licensed in the State of Alabama.

(c) Minimum Requirements for the Submittal of Design Calculations.

1. Configuration of the Design Submittal.

The design calculation sheets shall have the project number, wall location, initials of preparer, and page number at the top of each page. An index page shall be provided to provide a list of the pages of the design calculations.

The design calculations shall include an explanation of all symbols on the calculations and a description of computer programs used in the design.

2. Description of Design Methodology.

The design calculations shall contain a summary of the overall soil nail wall design methodology including references to the applicable design code requirements.

3. Diagrams of the Critical Cross Sections.

The design calculations shall include diagrams of the critical design cross section geometry including soil and rock strata and the location, magnitude, and direction of the design slope, external surcharge loads and piezometric levels. The design cross sections shall also include the critical slip surface shown where it will result in the minimum factor of safety, the required nail lengths, and the strengths of the soil nails (nail bar sizes and grades) for each nail row.

4. Physical Properties of the Rock and Soil.

The soil and rock shear strengths (friction angle and cohesion), unit weights, and ground-grout pullout resistances and nail drill hole diameter assumptions shall be shown for each soil and rock strata. Geotechnical data is provided in the contact documents. Supplementary geotechnical data may be available and may be obtained from the Materials and Tests Engineer.

5. Factors of Safety and Load Combinations.

Partial safety factors and strength factors (for Service Load Design, "SLD") or load and resistance factors (for Load and Resistance Factor Design, "LRFD") shall be shown for the global stability, pullout resistance, nail bar tensile strength, surcharges, soil and rock unit weights, nail head strengths, and steel, shotcrete, and concrete materials.

Load combinations and design loads used shall be given for a 75 year service life design for each wall on the project.

6. Wall Facing and Soil Nail Anchorage.

The design calculation submittal shall also include design calculations for the wall facing and nail anchorage including an analysis of the facing flexural strength, punching shear strength, tensile strength of the headed studs if used, and the upper cantilever and minimum reinforcement ratio.

(d) Minimum Requirements for the submittal of Wall Construction Drawings.

1. Plan View of the Wall.

A drawing of the plan view of the wall shall be submitted. The following details shall be shown on the plan view:

- A reference baseline and elevation datum;
- The offset from the construction centerline or baseline to the face of the wall at its base at all changes in horizontal alignment;
- Beginning and end of wall stations;
- Right-of-way and permanent or temporary construction easements limits, location of all known active and abandoned existing utilities, adjacent structures and other potential interferences.
- The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the wall;
- Limit of longest nail.

2. Elevation View of the Wall.

A drawing of the elevation view of the wall shall be submitted. The following details shall be shown on the elevation view:

- The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 30 feet along the wall;
- Elevations at the wall base and the top of leveling pads for any cast in place facing;
- Beginning and end of wall stations;
- The distance along the face of the wall to all steps in the wall base;
- Vertical and horizontal nail spacing with identification number assigned for each nail;
- The location of wall drainage elements;
- Expansion/contraction joints in the facing (if applicable);
- Existing and finish grade profiles both behind and in front of the wall;
- A listing of the quantities for each partial view of the wall.

3. Plan Notes and Miscellaneous Details.

Plan notes shall be placed on the Wall Construction Drawings to provide the information required to identify the design process and to serve as the requirements for the construction of the wall. This information shall be:

- A description of the design parameters with references to the applicable design codes;
- General notes for constructing the wall including construction sequencing;
- Horizontal and vertical curve data affecting the wall and wall control points;
- Match lines and other details to tie the wall stationing to the centerline stationing;
- A listing of the total summary of quantities showing the square yards of wall face areas, length of nails, amount of grout and other items of work;
- Nail wall typical sections including staged excavation lift elevations, the batter of the wall and excavation face, and nail size, spacing and inclination, and the details of corrosion protection;
- Drilling methods and equipment, including the drill hole diameter and any variation of the required diameters along the wall alignment;
- Grouting placement procedures and equipment;
- Provisions for drain holes behind the wall;
- Typical details of production nails and test nails defining the nail length, minimum drill hole diameter, inclination, and test nail bonded and unbonded test lengths;
- Details, dimensions, and schedules for all nails, reinforcing steel, wire mesh, bearing plates, headed studs and/or attachment devices for shotcrete, cast-in-place or prefabricated facings;
- Dimensions and schedules of all reinforcing steel including reinforcing bar bending details;

- Details and dimensions of all wall appurtenances such as barriers, coping, drainage gutters and fences;
- Details for constructing walls around drainage facilities;
- Details for terminating walls and adjacent slope construction;
- Details and procedures for performing the soil nail load capacity verification tests;
- Typical details of instrumentation installation along the verification nails, including the list of proposed instruments, complete and detailed installation procedures, a wiring diagram detailing the wiring of the instruments to the central readout panels, shop drawings and specifications for ancillary equipment such as readout panels, protective covers, conduit, and enclosures;
- Details and procedures for performing the soil nail proof load tests;
- Examples of forms used for documentation of installation and testing.

570.05 Approved List of Soil Nail Wall Specialty Contractors.

The following soil nail wall design-build specialty Contractors are approved:

Richard Goettle, Inc. 12071 Hamilton Ave. Cincinnati, OH 45231 Rick Slack Phone: 513-825-8100	Hayward Baker, Inc. 515 Nine North Court Alpharetta, GA 30004-3961 John Wolosick, P.E. Phone: 770-442-1801	Schnabel Foundation Co. 1654 Lower Roswell Road Marietta, GA 30068 Stephen Dimino Phone: 770-971-6455
F & W Construction PO Box 1549 Ozark, AL 36361 Phone: 334-774-2678	GeoStabilization International 2841 North Avenue Grand Junction, CO 81501 Reid Bailey Phone: 423-619-8576 www.geostabilization.com	Russo Corporation 1421 Mims Avenue SW Birmingham, AL 35211 Phone: 205-923-4434 www.russocorp.com

Other soil nail wall specialty Contractors will be given consideration for approval. Consideration for approval will be given to specialty Contractors that can provide documentation that they have successfully designed and constructed at least 3 projects in the last 3 years where the construction of permanent soil nail retaining walls totals at least 1000 square yards of wall face area and at least 500 permanent soil nails.

570.06 Construction Requirements.

(a) Site Drainage Control.

The Contractor shall control all surface water that will affect construction of the soil nail retaining wall. The Contractor shall maintain all pipes or conduits used to control surface water during construction. Damage caused by surface water shall be repaired without extra compensation. Upon substantial completion of the wall, surface water control pipes or conduits shall be removed from the site as directed by the Engineer. Alternatively, with the approval of the Engineer, pipes or conduits that are left in place may be fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from the migration of fines through the pipe or conduit creating potential ground loss.

Localized areas of perched water seepage may be encountered during excavation at the interface of geologic units or from localized groundwater seepage areas.

The Contractor shall immediately notify the Engineer if unanticipated existing subsurface drainage structures are discovered during excavation. The work shall be suspended in these areas until remedial measures meeting the Engineer's approval are implemented. The cost of remedial measures required to capture and dispose of water resulting from encountering unanticipated subsurface drainage structures will be paid for as Extra Work.

All surface water runoff flows and flows from existing subsurface drainage structures shall be captured and directed separately from the wall drainage network. These flows shall be conveyed to an outfall structure or storm sewer, as directed by the Engineer.

(b) Excavation.

1. Safety During Excavation and Compliance With Wall Construction Drawings.

The Contractor shall carefully monitor the excavation work to make sure that the soil nail wall is safely constructed. The wall construction and excavation sequence shall be performed in accordance with the requirements shown on the submitted Wall Construction Drawings as distributed

by Engineer. Excavations that are steeper or deeper than those shown on the Wall Construction Drawings shall not be made without written approval of the Engineer.

2. Excavation and Wall Alignment Survey Control

The Contractor shall provide all the necessary survey and alignment controls for all excavation work. The Contractor shall locate and drill each drill hole within the allowable tolerances.

The excavation shall be performed in a manner which will allow the construction of the shotcrete construction facing to the required minimum thickness and to the required lines and grades.

Where the as-built location of the front face of the shotcrete exceeds the allowable tolerance from the wall control line shown on the Wall Construction Drawings, the Contractor shall be responsible for determining and bearing the cost of remedial measures necessary to provide proper attachment of nail head bearing plate connections and satisfactory placement of the final wall facing.

3. Coordination of General Roadway Excavation with Wall Excavation.

The Contractor shall complete the clearing, grubbing, grading and excavation above and behind the wall before beginning the wall excavation. The initial excavation shall not extend beyond the original ground elevation behind the wall or at the ends of the wall or beyond the limits shown on the soil nail Wall Construction Drawings.

Due to the close coordination that is required between the work of the soil nail wall design-build specialty Contractor and the forces performing the excavation work, the excavation shall be performed as directed by the Engineer. The Engineer will be advised by the soil nail wall specialty Contractor of the need for setting the limits of excavation to allow the construction of the wall as proposed by the specialty Contractor.

For any required rock blasting within 200 feet of the soil nail wall the contractor shall submit a plan for the blasting using controlled blasting techniques. The plan shall be designed by a qualified Blasting Consultant deemed qualified for this work by the Engineer. Blasting shall not begin until the Engineer informs the Contractor that the blasting plan is adequate to describe the blasting and the Contractor accepts complete responsibility for the results of the blasting. Blasting shall not damage completed soil nail work or disrupt the areas where soil nails are required to be installed and shotcrete placed for the wall. The contractor shall repair any damaged areas without compensation.

General roadway excavation shall be done in coordination with the soil nailing work.

4. Soil Nail Wall Structure Excavation.

The Contractor shall perform the excavation to the final wall face using procedures that:

- Prevent over excavation;
- Prevent ground loss, swelling, air slaking, or loosening;
- Prevent loss of support for completed portions of the wall;
- Prevent loss of soil moisture at the face;
- And prevent ground freezing.

There will be no extra payment for costs associated with additional thickness of shotcrete or concrete or other remedial measures required due to irregularities in the cut face, excavation overbreak or inadvertent over excavation.

The exposed unsupported final excavation face cut height shall not exceed the vertical nail spacing plus the required reinforcing lap or the short-term stand-up height of the ground, whichever is less. The Contractor shall complete excavation to the final wall excavation line and complete the application of the shotcrete in the same work shift unless approved otherwise by the Engineer. Application of shotcrete may be delayed up to 24 hours if the Contractor can show that the delay will not adversely affect the stability of the excavation face of the wall. Placement of a polyethylene film over the face of the excavation may be required by the Engineer to reduce degradation of the cut face caused by changes in moisture. Damage to existing structures or completed portions of the wall structure shall be repaired without extra compensation where approval is given by the Engineer for the extended face exposure period.

At the Contractor’s option, during each excavation lift, nails may be drilled and installed through a temporary stabilizing berm if this is shown on the Wall Construction Drawings. The purpose of the stabilizing berm is to prevent or minimize instability or sloughing of the final excavation face due to ground conditions and drilling action. The stabilizing berm geometry shall be such that the top of berm extending horizontally out from the bottom front face of the overlying shotcrete a distance of 1 foot and cut down from that point to the base grade for that excavation lift at the slope not steeper than 1H:1V. The Contractor may use different berm geometry, upon satisfactory demonstration that the different geometry provides satisfactory performance.

Following the installation of nails in that lift, the Contractor shall excavate the temporary stabilizing berm to the final wall face excavation line and clean the final excavation face of all loose materials, mud and other foreign matter which could prevent or reduce shotcrete bond. The Contractor shall ensure that installed nails and corrosion protection are not damaged during excavation of the stabilizing berm. The Contractor shall repair or replace nails or corrosion protection that are damaged or disturbed during excavation of the stabilizing berm as directed by the Engineer without extra compensation. The Contractor shall not excavate the stabilizing berm until the nail grout has achieved a compressive strength of 1500 psi but not before 24 hours. Hardened nail grout protruding from the final wall excavation line more than 2 inches shall be removed in a manner that prevents the fracturing of the grout at the nail head. Sledge hammer removal of grout is not allowed. The use of hand held rock chippers is acceptable provided their use does not damage or disturb the remaining grout at the nail head, the nail bar or corrosion protection. Alternate excavation and soil nail installation methods that meet these objectives may be submitted to the Engineer for consideration by the Engineer.

Excavation to the next lift shall not proceed until nail installation, reinforced shotcrete placement, attachment of bearing plates and nuts and nail testing has been completed and accepted in the current lift. Nail grout and shotcrete shall have cured for at least 72 hours and shall have a minimum compressive strength of 1500 psi before the excavation of the next underlying lift.

The Contractor shall notify the Engineer immediately if raveling or local instability of the final wall face excavation occurs. Unstable areas shall be temporarily stabilized by means of buttressing the exposed face with an earth berm or other methods. The Contractor shall suspend work in unstable areas until remedial measures are developed.

5. Wall Discontinuities.

Where the Contractor's excavation and installation methods result in a discontinuous wall along any nail row, the ends of the constructed wall section shall extend beyond the ends of the next lower excavation lift by at least 10 feet. Slopes at these discontinuities shall be constructed to prevent sloughing or failure of the temporary slopes. If sections of the wall are to be constructed at different times, prevent sloughing or failure of the temporary slopes at the end of each wall section.

6. Excavation Face Protrusion, Voids, or Obstructions.

The Contractor shall remove all or portions of cobbles, boulders, rubble or other subsurface obstructions encountered at the wall final excavation face which will protrude into the design shotcrete facing. The Contractor shall be responsible for determining the method of removal of face protrusions, including the method required to safely secure remnant pieces left behind the excavation face and for promptly backfilling voids resulting from removal of protrusions. The Contractor shall notify the Engineer of the proposed method for removal of face protrusions at least 24 hours prior to beginning removal. Voids, overbreak and excessive excavation beyond the wall excavation line shall be backfilled with shotcrete. Removal of face protrusions and backfilling of voids and areas of excessive excavation shall be incidental to the work of constructing the wall.

(c) Shotcrete.

Shotcrete shall be placed in accordance with the requirements given in Section 571. Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, the nozzle shall be placed in the mouth of the drill hole to completely fill the void. The contractor shall attach a bearing plate and nut to each nail head as shown on the Wall Construction Drawings.

While the shotcrete is still plastic the bearing plate shall be uniformly seated on the shotcrete by hand wrench tightening of the nut. If uniform contact is not achieved between the plate and shotcrete, the nut shall be tightened by hand wrench tightening after the shotcrete has achieved initial set at 500 psi. (Initial set of the shotcrete is defined in Section 571.) The plate shall be set in a bed of grout where uniform contact between the plate and shotcrete cannot be provided. The nut shall be tightened by hand wrench tightening after the grout has achieved 1500 psi but not before 24 hours. If headed studs are required on the anchor plates they shall be located within the tolerances shown on the Wall Construction Drawings.

(d) Nail Installation.

1. Contractor's Responsibility for Soil Nail Configuration.

The Contractor shall determine the required drill hole diameters, soil nail orientation, drilling method, grout composition and installation method necessary to achieve the nail pullout resistances shown in the Wall Construction Drawings.

2. Load Verification Testing.

Drilling and installation of production nails will not be permitted in any soil or rock strata unit until successful load verification testing of nails is complete in that unit and the results are acceptable to the Engineer. If requested in writing, the Contractor may begin installation of production soil nails before verification testing is complete if approved in writing by the Engineer. If verification testing results in a change to the original soil nail design, then the Contractor will be responsible at no additional cost to the Department for the installation of any additional soil nails required to meet the new soil nail design requirements.

Load verification test nails shall be installed using the same equipment, methods, nail inclination and drill hole diameter as planned for the production nails. The number and location of the verification test nails shall be as shown on the Wall Construction Drawings.

Verification test nails may be installed through the existing slope face prior to start of wall excavation, drill platform work bench, stabilization berm or into slot cuts made for the particular lift in which the verification test nails are located. Slot cuts shall only be large enough to safely accommodate the drill and test nail reaction set up. If approved by the Engineer, verification test nails may also be installed at angle orientations other than perpendicular to the wall face or at different locations than required, as long as the Contractor can demonstrate that the test nails will be bonded into the ground which is representative of the ground at the verification test nail locations designated on the Wall Construction Drawings.

3. Allowable Placement of Facing Before Installation of Soil Nails.

At the request of the Contractor, and with the Engineer's approval, the shotcrete facing may be placed before drilling and installing the nails. A blockout shall be provided through the shotcrete facing at drill hole locations using PVC pipe or other suitable material, to prevent damage to the facing during drilling. As part of the required design submittals, the Contractor shall provide the Engineer with acceptable structural design calculations demonstrating that the facing structural capacity will not be reduced and that the bearing plates are adequate to span the nail drill hole blockout through the construction facing. If the presence of a blockout requires larger size bearing plates or additional reinforcement beyond that shown on the Wall Construction Drawings, there will be no extra compensation for this work.

4. Optional Sealing Layer for Protection of Face Of Excavation.

Where necessary for stability of the excavation face, the Contractor shall have the option of placing a sealing layer (flashcoat) of unreinforced shotcrete or steel fiber reinforced shotcrete or of drilling and grouting of nails through a temporary stabilizing berm of native soil to protect and stabilize the face of the excavation. There will be no extra compensation for a sealing layer.

5. Adjustments to Number and Location of Soil Nails.

The Engineer may add, eliminate, or relocate nails to accommodate actual field conditions. Cost adjustments associated with these modifications shall be made as Extra Work. There will be no extra compensation for the cost of any redesign, additional material, or installation modifications resulting from actions of the Contractor.

6. Orientation and size of Drilled Holes for the Soil Nails.

The drill holes for the soil nails shall be made at the locations, orientations, and lengths shown on the Wall Construction Drawings as directed by the Engineer. The Contractor shall select the drilling equipment and methods suitable for the physical properties of the ground where the nails will be installed.

The Contractor shall set the diameter of the drill hole that will result in the required load capacity of the nail and to also provide a minimum of 1/2 inch grout cover over the soil nail bars.

7. Removal of Drill Cuttings.

Drilling muds such as bentonite slurry shall not be used to assist in drill cutting removal. Compressed air may be used for cutting removal.

The Contractor may be allowed to use water, neat cement grout, or foam flushing upon successful demonstration to the Engineer that the installation method provides adequate nail pullout resistance.

If caving ground is encountered, the Contractor shall use cased drilling methods or other suitable means to support the sides of the drill holes.

8. Drilling through Hard Materials.

Where hard drilling conditions such as rock, cobbles, boulders, or obstructions are expected or encountered during drilling, percussion or other suitable drilling equipment capable of drilling and maintaining stable drill holes through these materials shall be used.

If percussion drilling is used the drilling operations shall be immediately suspended or modified if ground subsidence is observed, if the soil nail wall is adversely affected, or if adjacent structures are damaged. The Contractor shall immediately stabilize the excavation, wall and adjacent structures if adverse conditions occur. This stabilization shall be done without extra compensation.

9. Placement of Soil Nail Bars in Drilled Holes.

Centralizers shall be spaced along each soil nail so that the maximum spacing does not exceed 10 feet between the centers of the centralizers. Centralizers shall also be located 2 feet from the top and bottom of the drill hole. Centralizers shall be securely attached to the bar so they will not shift during handling or insertion into the drill hole. Centralizers shall be oriented to allow grout tremie pipe insertion to the bottom of drill hole and allow the grout to flow freely up the hole.

Each soil nail bar shall be inspected before installation and shall be repaired or replaced if the encapsulation is damaged. Uncased drill holes shall be checked for cleanliness prior to insertion of the soil nail bar. The Contractor shall provide a light source capable of adequately illuminating the bottom of each soil-nail drill hole. The light source shall be provided for the exclusive use of the Engineer.

Soil nail bars shall be inserted without forcing the insertion in a way that may damage the drill hole or the soil nail bar. Partially inserted soil nail bars shall not be driven into the drill hole. Soil nails which cannot be fully inserted to the required depth shall be removed and the drill hole shall be cleaned to allow unobstructed installation.

When using cased or hollow stem auger drilling equipment which does not allow for the centralizers to pass through the casing or auger stem, the Contractor may delete the centralizers if the grout pumped through the casing is placed using grout pressures greater than 150 psi or if the grout placed through the stem of the auger has a consistency of less than 125 % when tested in accordance with the requirements given in ASTM C 1107, "*Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)*".

10. Soil Nail Installation Tolerances.

Soil nails shall not extend beyond the right-of-way or easement limits shown on the Plans.

The allowable deviation of the soil nail head location shall be a maximum of 6 inches in any direction. The allowable deviation in the soil nail inclination shall be a maximum of 3 degrees. Location tolerances are applicable to only one nail and are not accumulative over large wall areas.

The soil nail bars shall be centered within 1 inch of the center of the drill hole.

Soil nails that are not installed within the allowable tolerances due to the Contractor's installation methods shall be replaced without extra compensation.

11. Abandoned Drill Holes.

Drill holes where unanticipated obstructions are encountered during drilling shall be relocated, as directed by the Engineer. The cost of drilling and backfilling drill holes abandoned due to unanticipated obstructions will be paid as Extra Work.

There will be no extra compensation for the cost of drilling and backfilling drill holes abandoned due to errors made by the Contractor.

(e) Grouting.

1. Testing of Grout placed for Anchorage.

Grout placed for the anchorage of the soil nails shall have a minimum compressive strength of 1500 psi at 3 days, and a minimum compressive strength of 3000 psi at 28 days when tested in accordance with the requirements given in AASHTO T 106.

The Contractor shall make arrangements for an ALDOT approved testing laboratory to make specimens and test the grout each day that grout is being placed. Three cubes (2 inch x2 inch) for each test age shall be produced at a frequency of at least once per every 30 cubic yards, or fraction thereof, of grout placed. Cubes shall be molded and cured in accordance with the requirements of AASHTO TP 83, "Sampling and Fabrication of 50-mm (2in.) Cube Specimens Using Grout (Non-Shrink) or Mortar", and tested in accordance with the requirements given in AASHTO T 106. Test reports shall be delivered to the Engineer within 24 hours from testing.

2. Grouting Equipment.

Grout equipment shall produce a uniformly mixed grout free of lumps and shall be capable of continuously agitating the mix. A positive displacement grout pump shall be used. The grout pump shall be equipped with a pressure gauge which can measure at least twice but not more than three times the intended grout pressure. The grouting equipment shall be sized to enable the entire nail to be grouted in one continuous operation.

3. Time of Placing Grout.

Grout shall be placed within 60 minutes after mixing. Grout not placed in the allowed time limit will be rejected.

4. Grouting Methods.

Each drill hole shall be grouted during drilling or within 2 hours of completion of drilling, unless otherwise approved by the Engineer.

Grout shall be injected through a tremie, casing, hollow-stem auger, or drill rods at the lowest point of each drill hole. The outlet end of the conduit delivering the grout shall be kept below the surface of the grout as the conduit is withdrawn to prevent the creation of voids.

The drill holes shall be filled in one continuous operation. Cold joints in the grout column are not allowed except at the top of the test bond length of proof load tested production nails. At the Contractor's option, the tremie may remain in the hole provided it is filled with grout. Grouting before insertion of the nail is allowed provided the nail bar is immediately inserted through the grout to the specified length without difficulty.

During casing removal for drill holes advanced by either cased or hollow-stem auger methods, a sufficient level of grout shall be maintained within the casing to offset the external groundwater and soil pressure and prevent hole caving. The grout head or grout pressures shall be maintained to ensure that the drill hole will be completely filled with grout and to prevent unstable soil or groundwater from contaminating or diluting the grout. The grout pressures shall be recorded for soil nails installed using pressure grouting techniques. Grout pressures shall be controlled to prevent excessive ground heave or fracturing. The grout pressure gauge shall be capable of measuring at least twice but not more than three times the intended grout pressure.

The grout and soil nail shall be removed if grouting is suspended for more than 30 minutes or grouting is not in compliance with the general requirements for grouting. Fresh grout and an undamaged soil nail bar shall be placed without extra compensation if the grouting is unacceptable.

(f) Wall Drainage Network.

The contractor shall install and secure all elements of the wall drainage network as shown on the Wall Construction Drawings or as required by the Engineer to suit the site conditions. The drainage network shall consist of installing geocomposite drain strips, connection pipes and wall footing drains as shown on the Wall Construction Drawings or as directed by the Engineer. Exclusive of the wall footing drains, all elements of the drainage network shall be installed prior to shotcreting.

Unanticipated subsurface drainage features exposed in the excavation cut face shall be captured independently of the wall drainage network and shall be mitigated prior to shotcrete application. Costs due to the required mitigation will be paid for as Extra Work.

Geocomposite Drain Strips shall be installed with the drain strips centered between the columns of nails as shown on the Wall Construction Drawings. The drain strips shall be at least 12 inches wide and shall be placed with the geotextile side against the ground. The contractor shall secure the strips to the excavation face and prevent shotcrete from contaminating the ground side of the geotextile. Drain strips shall be vertically continuous. Splices shall be made with a 12 inch minimum overlap so that the flow of water will not be impeded. The contractor shall repair any damage to the geocomposite drain strip, which may interrupt the flow of water.

The contractor shall install footing drains at the bottom of each wall shown on the Wall Construction Drawings. The drainage geotextile shall envelope the footing drain aggregate and pipe and shall conform to the dimensions of the trench. The drainage geotextile shall overlap the top of the drainage aggregate as shown on the Wall Construction Drawings. The contactor shall repair or replace damaged or defective drainage geotextile without extra compensation.

Connection pipes, as shown on the Wall Construction Drawings, shall direct water from the geocomposite drain strips into the footing drain or to the exposed face of the wall. The connection pipes shall be connected to the drain strips using either prefabricated drain grates as shown on the Wall Construction Drawings or the alternate method of connection. The drain grate shall be installed

per the manufacturer's recommendations. The joint between the drain grate and the drain strip and the discharge end of the connector pipe shall be sealed to prevent shotcrete intrusion.

An alternative method for connecting the connector pipe to the drain strip shall be cutting a hole slightly larger than the diameter of the pipe into the strip plastic core but not through the geotextile. The contractor shall wrap both ends of the connection pipe in the geotextile in a manner that prevents migration of fines through the pipe. The connector pipe inlet end where it penetrates the drain strip and the discharge end shall be taped or sealed in a manner that prevents penetration of shotcrete into the drain strip or pipe. To assure passage of groundwater from the drain strip into the connector pipe, the contractor shall slot the inlet end of the connector pipe at every 45 degrees around the perimeter of the pipe to a depth of 0.25 inches.

Weepholes shall be provided through the construction facing to drain water from behind the facing. Weepholes shall be installed as shown on the Wall Construction Drawings. Drainage outlet pipe shall be used to form the weephole through the shotcrete. The end of the pipe contacting the soil with the drainage geotextile shall be covered. Intrusion shall be prevented into the discharge end of the pipe.

(g) Load Testing of Soil Nails.

The Contractor shall perform both load capacity verification testing prior to the installation of production nails and proof load testing of designated production test nails. Load capacity verification tests shall be performed on sacrificial test nails at the locations shown on the Wall Construction Drawings. Proof load tests shall be performed on production nails at locations selected by the Engineer. The required load test data will be recorded by the Engineer.

(h) Verification Testing of Sacrificial Test Nails.

1. Purpose and Extent of Load Capacity Verification Tests.

Load capacity verification testing shall be performed prior to installation of production nails as a means to validate the theoretical nail pullout resistance. It shall also be a demonstration of the Contractor's installation methods.

A minimum of 2 verification tests shall be performed in each different soil or rock strata and for each different drilling or grouting method proposed to be used.

Tension loads shall be applied to a sacrificial test nail in increasing increments. The movement of the nail due to the increasing load will be monitored. The load in the nail and the corresponding movement of the nail will be used in evaluating the proposed construction methods and details. Excessive movement of the nail due to the loading is evidence that the details of the soil nail are inadequate to carry the load of the wall.

Verification test nails shall be sacrificial and shall not be incorporated as production nails. The bars installed for testing shall be epoxy coated and encapsulated, if epoxy coating and/or encapsulation is required, in the same manner as the production bars.

2. Submittal of Details of Load Capacity Verification Tests.

The Contractor shall submit the details of the verification testing arrangement including the method of distributing test load pressures to the excavation surface (reaction frame), test nail bar size, grouted drill hole diameter and reaction frame dimensioning. Testing equipment shall include dial gauges, dial gauge support, a jack and pressure gauge, an electronic load cell, strain gauges, and readout panels. The load cell is required for the creep test portion of the verification test.

Where temporary casing of the unbonded length of test nails is proposed, the details shall be submitted to show how the casing will be prevented from reacting with the grouted bond length of the nail and the testing apparatus.

The Engineer will review the submittal for completeness. The requirement for this submittal is given with the requirements for the submittal of the details of the wall. The testing shall not begin until the Engineer informs the Contractor that the submittal is complete.

3. Instrumentation Details of Load Capacity Verification Tests.

The Contractor shall instrument the verification test nails to obtain direct measurements of axial strains and evaluate the load transfer along the length of the nails. The instrumentation shall be installed within both the bonded and unbonded portions of the verification nails. The gauges shall be installed either along the length of the nail or, in the case of hollow bar soil nails, within the hollow portion of the bar, after final grouting.

The Contractor shall develop an instrumentation plan which shall be submitted with the Wall Construction Drawings. The instrumentation shall be installed by a qualified geotechnical instrumentation specialist having experience in the design and installation of instrumentation systems on at least 3 similar projects. The Contractor shall submit the experience record(s) of the individual(s)

responsible for instrument installation and testing. The requirement for this submittal is given with the requirements for the submittal of the details of the wall design and drawings.

At the completion of each verification nail test, the Contractor shall supply the Engineer with a plot of the load versus depth along the length of the nail, along with calculations of bond stresses along the bond zone of the tested nail. The Engineer will verify that the load transfer values used in the design are valid based on the verification test results.

4. Load Capacity Verification Test Equipment.

The reaction frame shall be sufficiently rigid and of adequate dimensions so that excessive deformation of the testing equipment does not occur. If the reaction frame will bear directly on the shotcrete facing, it shall be designed to prevent cracking of the shotcrete. The reaction frame shall be supported independently of the soil nail and shall be configured to allow the placement of the jack over the nail bar so that the bar does not carry the weight of the testing equipment.

The configuration of the testing apparatus shall be designed so that the jack, bearing plates, and stressing anchorage will not need to be repositioned during a test.

The load shall be applied with a hydraulic jack and measured with a pressure gauge. The pressure gauge shall be graduated in 75 psi increments or less. The jack and pressure gauge shall have a load range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment. All jacks, pressure gauges, pumps and load cells shall have been calibrated with each other within the last 6 months by an independent AASHTO accredited laboratory or by a Department laboratory. Calibrated jacks, gages, pumps and load cells shall have identifiable serial numbers to insure traceability to calibration tests.

The nail head movement shall be measured with a dial gauge capable of measuring the movement to an accuracy of 0.001 inch. The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge. The dial gage shall be designed to be aligned parallel with the axis of the nail. The dial gage shall be supported independently from the jack, wall and reaction frame. Two gages will be required when the load reaction is placed on the face of a soil cut.

5. Installation of Sacrificial Test Nail for Load Verification Tests

The Contractor shall install the sacrificial test nails using the same equipment, installation methods, nail inclination, and drill hole diameter that is proposed for the production nails. Changes in the drilling or installation method will result in the requirement for additional verification testing as determined by the Engineer. Additional verification testing shall be performed by the Contractor without extra compensation. Payment for additional verification tests required due to differing site conditions, if determined by the Engineer, will be made at the contract unit price for this work.

6. Required Strength of Nail Grout and Shotcrete Prior to Load Testing.

Verification load testing shall not be performed until the nail grout and shotcrete facing have cured for at least 72 hours and have attained the required compressive strength of 1500 psi.

Load testing in less than 72 hours may be allowed if the Contractor submits compressive strength test results showing that the compressive strength of the grout and shotcrete is 1500 psi, but no load test shall be performed before 24 hours regardless of the strength of the grout and shotcrete. The Contractor shall make arrangements for an ALDOT approved testing laboratory to test the grout.

7. Bonded and Unbonded Lengths of Sacrificial Test Nails.

Load verification test nails shall have both bonded and unbonded lengths. The bonded length of the nail shall be grouted prior to testing. The bonded length shall be determined based on the nail bar grade and size and the theoretical pullout resistance of the nail.

The bonded length shall not be less than 10 feet. The unbonded length shall not be less than 3 feet.

8. Allowable Load on Bar of Sacrificial Test Nail.

A test load shall be determined based on the theoretical pullout resistance of the soil or rock that a production nail will be embedded in. This test load shall not be greater than the allowable tensile stress of the bar. The allowable tensile stress during testing shall not be greater than 90 % of the yield strength for Grade 60 and Grade 75 bars, or 80 % of the ultimate strength for Grade 150 bars.

Loads larger than the load capacity of the production bars may be required to safely test the theoretical pullout resistance where the minimum 10-foot bonded length is required. The Contractor shall provide larger verification test bar sizes if a larger bar is required to safely apply the load required for the measurement of the movement of the test nail under load.

9. Determination of the Maximum Bonded Length of a Sacrificial Test Nail.

A maximum bonded length shall be constructed for the verification test of a sacrificial test nail.

The maximum bonded length shall first be calculated based on the strength of the production soil nail bar and the pullout resistance of the soil or rock. The required test load shall then be calculated based on the bonded length of the test nail and the pullout resistance.

If the maximum bonded length from the initial calculation is less than 10 feet the required maximum bond length shall be 10 feet. The required test load shall then be calculated based on the bonded length of the test nail and the pullout resistance of the 10 foot bonded length. The load carrying capacity of the nail bar shall then be checked. A larger size bar shall be furnished if this is required to carry the test load.

The following equation shall be used for determining the verification test nail maximum bonded length:

$L_{BV} = C\ f_y\ A_s/2\ Q_d$, or 120 inches, whichever is greater;

- L_{BV} = Maximum Verification Test Nail Bonded Length (inches);
- C = 0.9 for Grade 60 and 75 bars and 0.8 for Grade 150 bars;
- f_y = Bar Yield or Ultimate Stress (pounds per square inch); *(Note: fy = 60,900 psi, 75,400 psi and 150,100 psi respectively for grade 60, 75 and 150 bars)*;
- A_s = Bar Steel Area (square inches);
- 2 = Pullout resistance safety factor;
- Q_d = Allowable pullout resistance (pounds per inch) of grouted nail.

10. Determination of the Verification Test Load.

The following equation shall be used for determining the Verification Test Load (VTL):

$VTL = L_{BV}\ X\ Q_d$;

- VTL = Verification Test Load (pounds).

11. Verification Loading of a Sacrificial Test Nail.

Verification test nails shall be incrementally loaded to a maximum load of 200 % of the Verification Test Load (VTL) in accordance with the following loading schedule. The soil nail movements shall be recorded at the end of each load increment.

VERIFICATION TEST LOADING SCHEDULE	
LOAD	HOLD TIME
AL = 0.05 VTL, Max.	1 minute
0.25 VTL	10 minutes
0.50 VTL	10 minutes
0.75 VTL	10 minutes
1.00 VTL	10 minutes
1.25 VTL	10 minutes
1.50 VTL (Creep Test)	60 minutes
1.75 VTL	10 minutes
2.00 VTL (Max. Test Load)	10 minutes

The alignment load (AL) shall be applied to align the testing apparatus and shall not exceed 5 % of the Verification Test Load (VTL). Dial gauges for measuring the movement of the test nail shall be set to "zero" after the alignment load has been applied.

Each load increment after the alignment load shall be held for at least 10 minutes except for the creep test load increment. The verification test nail shall be monitored for creep for a minimum of 60 minutes at the 1.50 VTL load increment.

Nail movement shall be recorded during the creep portion of the test at 1 minute, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minutes. The load during the creep test shall be maintained within 2 % of the required load by use of the load cell.

(i) Proof Load Testing of Production Soil Nails.

1. Purpose and Extent of Proof Load Testing.

Load capacity proof load testing shall be performed on production nails to make sure that the actual installation of these nails is adequate to support the soil nail wall structure.

Proof load testing shall be performed on at least 5 % (1 in 20) of the production nails in each nail row or a minimum of 1 nail per row. Prior to soil nail installation on each row, the testing locations

will be selected with the random number method outlined in ALDOT-210. The Contractor shall proof load the soil nails selected by the Engineer.

A verification test nail that acceptably passes the verification test shall not be considered equivalent to a proof load test nail and shall not be used in determining the number required proof load tests.

Tension loads shall be applied to a proof load test nail in increasing increments. The movement of the nail due to the increasing load will be monitored. The load in the nail and the corresponding movement of the nail will be used in evaluating the acceptability of the soil nails that are represented by the proof load test nail. Excessive movement of the nail due to the loading is evidence that the installed soil nails are inadequate to carry the load of the wall.

2. Submittal of Details for Proof Load Testing.

The Contractor shall submit the details of the proof load testing apparatus. The Engineer will review the submittal for completeness. The requirement for this submittal is given with the requirements for the submittal of the details of the wall. The testing shall not begin until the Engineer informs the Contractor that the submittal is complete. Most of the testing equipment should be the same, or be very similar to the equipment required for the load capacity verification tests.

3. Required Strength of Nail Grout and Shotcrete prior to Proof Load Testing.

Proof load testing shall not be performed until the nail grout and shotcrete have reached the strengths required for the grout and shotcrete when performing a load capacity verification test.

4. Bonded and Temporary Unbonded Lengths of Proof Load Test Nails.

Proof load test nails shall have both bonded and temporary unbonded lengths. The bonded length of the nail shall be grouted prior to testing. The bonded length shall be determined based on the production nail bar grade and size and the theoretical pullout resistance of the nail.

The bonded length shall not be less than 10 feet for soil nails that are 13 feet long and longer. The bonded length may be less than 10 feet for soil nails that are shorter than 13 feet long. The temporary unbonded length shall not be less than 3 feet unless otherwise approved by the Engineer.

5. Allowable Load on Bar of Proof Test Nail.

The allowable tensile stress during testing shall not be greater than 90 % of the yield strength for Grade 60 and Grade 75 bars, or 80 % of the ultimate strength for Grade 150 bars.

6. Determination of the Maximum Bonded Length of a Proof Load Test Nail.

A maximum bonded length shall be constructed for the proof load test of a production soil nail.

The maximum bonded length shall first be calculated based on the strength of the production soil nail bar and the pullout resistance of the soil or rock. The required test load shall then be calculated based on the bonded length of the test nail and the pullout resistance.

If the maximum bonded length from the initial calculation is less than 10 feet and the bar is 13 feet long or longer the required maximum bond length shall be 10 feet. If the maximum bonded length from the initial calculation is less than 10 feet and the bar is shorter than 13 feet long, the required maximum bond length shall be the length determined from the calculation. The required test load shall then be calculated based on the bonded length of the test nail and the pullout resistance of the bonded length.

The following equation shall be used for determining the proof test nail maximum bonded length:

$L_{BP} = C\ f_Y\ A_S / 1.5\ Q_d$, or 120 inches if the bar is 13 feet long or longer;

- L_{BP}= Maximum Proof Load Test Nail Bonded Length (inches);
- C = 0.9 for Grade 60 and 75 bars and 0.8 for Grade 150 bars;
- f_Y = Bar Yield or Ultimate Stress (pounds per square inch); *(Note: fy = 60,900 psi, 75,400 psi and 150,100 psi respectively for Grade 60, 75 and 150 bars)*;
- A_S = Bar Steel Area (square inches);
- 1.5 = Pullout resistance safety factor;
- Q_d = Allowable pullout resistance (pounds per inch) of grouted nail.

7. Determination of the Proof Test Load.

The following equation shall be used for determining the Verification Test Load (VTL):

$PTL = L_{BV}\ X\ Q_d$;

- PTL = Proof Test Load (pounds).

8. Proof Loading of a Test Nail.

Proof tests shall be performed by incrementally loading the proof load test nail to a maximum test load of 150 percent of the Proof Test Load (PTL) in accordance with the following loading schedule. The nail movement shall be recorded at the end of each load increment. At load increments other than the maximum load, the load shall be held long enough to obtain a stable reading.

PROOF TEST LOADING SCHEDULE	
LOAD	HOLD TIME
AL = 0.05 PTL Max.	Until stable
0.25 PTL	Until stable
0.50 PTL	Until stable
0.75 PTL	Until stable
1.00 PTL	Until stable
1.25 PTL	Until stable
1.50 PTL (Max. Test Load)	See Below (Creep Test)

The alignment load (AL) should be the minimum load required to align the testing apparatus and should not exceed 5 percent of the Proof Test Load (PTL). Dial gauges for measuring the movement of the test nail shall be set to "zero" after the alignment load has been applied.

All load increments shall be maintained within 5 percent of the intended load. Depending on performance, either 10 minute or 60 minute loading duration creep tests shall be performed at the maximum test load (1.50 PTL). The creep test period shall start as soon as the maximum test load is applied and the nail movement shall be measured and recorded at 1 minutes, 2, 3, 5, 6, and 10 minutes. Where the nail movement between 1 minute and 10 minutes exceeds 0.04 inches, the maximum test load shall be maintained an additional 50 minutes and movements shall be recorded at 20 minutes, 30, 50, and 60, minutes.

(j) Acceptance Criteria for Verification and Proof Load Testing.

1. Verification Test Acceptance Criteria for Creep Test.

The test is acceptable when the total creep movement is less than 0.08 inches per log cycle of time between the 6 and 60 minute readings measured during creep testing and the creep rate is linear or decreasing throughout the creep test load hold period.

2. Proof Load Test Acceptance Criteria for Creep Test.

The test is acceptable when a total creep movement of less than 0.04 inches is measured between the 1 and 10 minute readings or a total creep movement of less than 0.08 inches is measured between the 6 and 60 minute readings and the creep rate is linear or decreasing throughout the creep test load hold period.

3. Verification and Proof Load Test Acceptance Criteria for Elongation.

The test is acceptable when the total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.

4. Verification and Proof Load Test Failure due to Pullout.

The test is acceptable when a pullout failure does not occur at the maximum test load. Pullout failure shall be defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the test nail. The pullout failure load shall be recorded as part of the test data.

(k) Criteria for Incorporating Proof Load Tested Nails as Production Nails.

Proof loaded test nails that meet the acceptance criteria may be incorporated as production nails if:

- The unbonded length of the test nail drill hole has not collapsed during testing;
- The minimum required drill hole diameter has been maintained;
- The specified corrosion protection is provided and;
- The test nail length is equal to or greater than the scheduled production nail length.

Proof loaded test nails meeting these requirements shall be completed by satisfactorily grouting up the unbonded test length. The Contractor shall be responsible for maintaining the temporary unbonded test length for subsequent grouting. If the unbonded test length of production proof load test nails cannot be satisfactorily grouted subsequent to testing, the proof test nail shall become sacrificial and shall be replaced with an additional production nail installed without extra compensation.

(l) Work Required to Address the Failure of a Load Verification Test.

The Engineer will evaluate the results of each verification test. Propose installation methods which do not result in acceptable load verification tests will be rejected. The Contractor shall proposed alternative methods and shall install replacement verification test nails. Replacement test nails shall be installed and tested without compensation.

(m) Required Work After Failure of a Proof Load Test.

The Engineer may require the Contractor to replace some or all of the installed production nails between a failed proof load test nail and the adjacent passing proof test nail. Alternatively, the Engineer may require the installation and testing of additional proof test nails to verify that adjacent previously installed production nails have sufficient load carrying capacity. Contractor modifications may include, but are not limited to; the installation of additional proof test nails; increasing the drill hole diameter to provide increased capacity; modifying the installation or grouting methods; reducing the production nail spacing from that shown on the Plans and installing more production nails at a reduced capacity; or installing longer production nails if sufficient right-of-way is available and the pullout capacity behind the failure surface controls the allowable nail design capacity. The nails may not be lengthened beyond the temporary construction easement or the permanent right-of-way shown on the Plans. Installation and testing of additional proof load test nails or installation of additional or modified nails as a result of proof load test nail failure(s) shall be done without compensation.

(n) Records of Soil Nail Wall Construction.

Records documenting the soil nail wall construction, including records of the installation and testing of soil nails, shall be produced and maintained in a manner acceptable to the Engineer. The Contractor shall provide the Engineer with copies of these records at the times designated by the Engineer.

570.07 As-Built Drawings and Revised Design Calculations.

The Contractor shall revise the Wall Construction Drawings when plan dimensions are revised due to field conditions or for other reasons. Within 30 calendar days after completion of the work, the Contractor shall submit as-built drawings to the Engineer. The Contractor shall also provide revised design calculations signed by the Licensed Professional Engineer that sealed the submittal of the design of the wall.

570.08 Workmanship Warranty.

The soil nail contractor will warrant the stability and workmanship of the slope following the techniques specified in this special provision. The warranty shall be for a period of 5 years from date of acceptance of the work. The warranty shall not reduce or affect any separate warranty on materials or products as stated in this special provision. The warranty applies to all perils which may affect the work, any area that becomes unstable, i.e., a failure within the modeled cross sections and potential failure planes, and the work of any subcontractor or vendor of the soil nail contractor. If an unstable condition occurs, then the soil nail contractor shall repair all failures within 30 days of receipt of verbal or written notification by ALDOT.

This warranty excludes acts of God and except as stated above, work of a third party that causes an unstable condition or damages the work performed by the soil nail contractor.

570.09 Temporary Soil Nail Walls.

Temporary Soil Nail Walls are those walls used for excavation shoring and which have a service life less than 18 months. Temporary soil nail walls shall be designed and constructed as required herein, with the following exceptions:

- Soil nail walls for temporary applications in non-aggressive environments can be designed with no corrosion protection except grout encapsulation of the bars. Centralizers on the bars at minimum 10 feet spacing are required.
- An as-shot or rough-screeded finish is satisfactory.
- The minimum shotcrete thickness shall be at least the design thickness less 0.5 inches.
- Minimum reinforcing cover shall be 2 inches.
- No contraction joints or special construction joints are required.
- Except for protection from freezing, no special protection or curing of the shotcrete is required.

570.10 Method of Measurement.

The Soil Nail Wall will be measured in units of square yards of the shotcrete face of the wall. Measurement will not be made outside of the limits (vertical and horizontal) of the shotcrete face of the wall shown on the plans or designated by the Engineer.

Excavation for Construction of Soil Nail Wall will be measured as the theoretical volume in cubic yards within the structure excavation limits shown on the Plans. This will be the excavation volume within the zone measured from the top of the shotcrete wall facing to the bottom of the wall. There will be no measurement of the excavation beyond the limits of excavation shown on the Plans.

570.11 Basis of Payment.

(a) Unit Price Coverage.

The Soil Nail Wall will be paid for at the contract unit price. This payment shall be full compensation for all submittals, labor, equipment, tools, materials, material tests, field tests and incidentals necessary to acceptably fabricate and test the wall components and construct the wall. This shall also be full compensation for furnishing and placing the reinforcing steel for the wall facing.

The contract unit price for Excavation for Soil Nail Wall shall be full compensation for all equipment, tools and labor required for the excavation and disposal of the excavated materials.

(b) Payment will be made under Item No.:

570-A Soil Nail Wall – per square yard
570-B Excavation for Soil Nail Wall – per cubic yard
570-C Temporary Soil Nail Wall – per square yard

SECTION 571
SHOTCRETE

571.01 Description.

This work shall consist of furnishing and placing one or more courses of shotcrete and reinforcing steel on a prepared surface. The shotcrete shall be a concrete mixture that is pneumatically projected at high velocity onto the surface.

571.02 Materials.

(a) General.

Materials shall conform to the requirements given in Division 800, Materials. Specific reference is made to applicable portions of the following Sections:

Section 801 Coarse Aggregate
Section 802 Fine Aggregates
Section 806 Mineral Admixtures
Section 807 Water
Section 808 Air Entraining Admixtures
Section 809 Chemical Admixtures for Concrete
Section 815 Cement
Section 835 Steel Reinforcement
Section 852 Underdrain Pipe Materials

(b) Aggregates.

When coarse aggregates are used, the coarse and fine aggregate shall be weighed separately to avoid segregation. Oversize pieces of aggregate shall be removed by screening. The combined aggregates shall meet one of the following gradations:

GRADATIONS FOR COMBINED AGGREGATES FOR SHOTCRETE		
SIEVE SIZE	PERCENT BY WEIGHT PASSING INDIVIDUAL SEIVES	
	GRADATION No. 1	GRADATION No. 2
3/4 inch	--	--
1/2 inch	--	100
3/8 inch	100	90 – 100
No. 4	95 – 100	70 – 85
No. 8	80 – 100	50 – 70
No. 16	50 – 85	35 – 55
No. 30	25 – 60	20 -35
No. 50	10 – 30	8 – 20
No. 100	2 – 10	2 – 10

(c) Shotcrete Mix Design.

The Contractor shall design the shotcrete mix and shall verify the performance of the design of the mix by trial mixes and laboratory tests. The Contractor shall submit the proposed mix design and test results to the Materials and Tests Engineer.

The placement of the shotcrete shall not begin until the mix design is approved through field placement tests and compressive strength testing described in Article 571.03.

Type I or Type III cement shall be used. The type and dosage of mineral and chemical admixture, if proposed for use, shall be included in the mix design, verification mixes, and production mix. The design, verification, and production of shotcrete mixes shall result in the shotcrete having the following properties:

PHYSICAL PROPERTIES OF SHOTCRETE				
TYPE OF SHOTCRETE PLACEMENT PROCESS	MINIMUM CEMENTITOUS MATERIAL CONTENT (POUNDS PER CUBIC YARD	MAXIMUM WATER-CEMENTITOUS MATERIAL RATIO (W/C) (1)	AIR CONTENT RANGE, EA(2) (%)	MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS(3) (psi)
Wet	550	0.55	NA	4000
Dry	550	0.50	NA	4000
Wet (w/TAC(2))	550	0.45	2.5 to 6.0	4000
Notes: (1) W/C = Water-Cementitious Ratio (by weight). (2) TAC = Total Air Content (3) As per AASHTO T 23				

(d) Mineral Admixtures.

Fly ash may be used as part of the cementitious material in the shotcrete mix. Class “F” or Class “C” fly ashes may be substituted for cement up to a maximum substitution rate of 20 % of the total weight of the cementitious materials.

Ground Granulated Blast Furnace Slag (GGBFS) may be used as part of the cementitious material in the shotcrete mix. GGBFS may be substituted for cement up to a maximum substitution rate of 30 % of the total weight of the cementitious materials.

Microsilica may be used as part of the cementitious material in the shotcrete mix. Microsilica may be added up to a maximum addition rate of 10 % of the total weight of the cementitious materials.

(e) Chemical Admixtures.

Air entraining admixtures and water reducing admixtures may be used for wet-mix shotcrete only. Type "F" admixtures may be used for wet-mix shotcrete only to promote workability without exceeding the maximum allowable water-cementitious ratio.

Admixture addition rates, dispensing, and mixing of the admixture shall be in accordance with the admixture manufacturer's recommendations.

571.03 Construction.

(a) Anchorage and Reinforcement.

The details of the anchorage and reinforcement of the shotcrete will either be shown on the plans or will be given elsewhere in the specifications when the shotcrete is required as a part of other items of work.

(b) Batching, Mixing and Placing Shotcrete.

The requirements for batching, mixing and placing shotcrete shall be as described in ACI 506R, "Guide to Shotcrete". Metal wires shall be used to control the thickness and surface of the shotcrete. The temperature of the shotcrete mix shall be maintained between 50 º F and 90 º F.

(c) Equipment.

1. Submittal of Description of Equipment.

The Contractor shall submit a written description of the proposed equipment for mixing and applying shotcrete. The submittal shall include the equipment manufacturer's instructions, recommendations, literature, performance, and test data. This submittal shall be delivered to the Engineer. The placement testing of the shotcrete shall not begin until the Engineer informs the Contractor that the submittal is complete and the proposed mix design (or designs) have been evaluated for completeness by the Materials and Tests Engineer.

The Contractor may use the information given in ACI 506R for identifying the equipment required for mixing and applying shotcrete.

2. Water Supply System for the Dry Mix Process.

For the dry-mix process the Contractor shall provide a water storage tank at the job site. The Contractor shall also provide a positive displacement pump with a regulating valve that is accurately controlled to provide water at the required pressure and volume.

3. Mixing and Placing Equipment.

The Contractor shall use equipment capable of handling and applying shotcrete containing the proposed maximum size aggregate and admixtures.

4. Air Hose and Blowpipe.

An air hose and blow pipe shall be provided by the Contractor to clear dust and rebound during shotcrete application.

5. Air Supply System.

An air supply system shall be provided by the Contractor. The air supply system shall be capable of supplying the delivery machine and hose with air at the pressures and volumes recommended by the machine manufacturer. Air supply systems that deliver oil-contaminated air, or are incapable of maintaining constant pressure shall not be used.

(d) Testing of Materials and Placement Process prior to Construction.

1. Requirement for Field Testing.

The Contractor shall perform a field test at least 30 calendar days before starting shotcrete production. The proposed mix design (or designs) shall be tested using the same equipment and personnel that will be used in production. The Contractor shall make arrangements for the Engineer to be present at the placement of the shotcrete for testing and at all of the subsequent testing of the samples of the shotcrete.

2. Test Panels from Field Tests.

Application of shotcrete on test panels shall be done in the same manner that will be used for the production placement of the shotcrete. Test panels shall be fabricated in accordance with the requirements given in ASTM C 1140, "Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panel", as may be modified by the requirements given in this Section.

The proposed mix shall be tested on two panels at least 3 feet by 3 feet in size. The thickness of the test panels shall be the same thickness as is required for the production placement. One panel shall be reinforced exactly like the production shotcrete will be reinforced.

Test panels shall be cured in the same manner that the production shotcrete will be cured.

3. Coring Test Panels.

Six cores shall be obtained from each test panel for testing. Each core shall be 3 inches in diameter and the full thickness of the test panel. The cores shall be taken from each test panel in

accordance with the requirements given in AASHTO T 24. Cores shall be extracted no more than 2 hours before testing.

4. Testing of Cores from Test Panels.

Three cores from the unreinforced panel shall be tested for compressive strength at an age of 7 days. Three cores from the unreinforced panel shall be tested for compressive strength at an age of 28 days. Compressive strength tests shall be performed in accordance with the requirements given in AASHTO T 24, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete".

Six cores shall be extracted from the reinforced panel at an age of 7 days for visual evaluation and nozzle operator qualification. These cores shall be delivered to the Materials and Tests Engineer for evaluation. The cores will be graded according to the requirements given in ACI 506.2, "Specification for Shotcrete".

(e) Submittal of Material Test Data and Proposed Placement Process.

The Materials and Tests Engineer will approve or reject the proposed mix design and placement process based on the results of the field testing and laboratory tests. Any changes to a previously accepted mix or the proposal of a new mix design will require field testing and laboratory testing before approval.

The Contractor shall submit three copies of the test data and proposed placement process data to the Engineer for evaluation by the Materials and Tests Engineer. This data shall be submitted within 4 calendar days after the completion of the compressive strength tests that are performed on the cores at 28 days of age. The following data shall be submitted:

- Sample identification including mix design and test panels represented.
- Date and time of sample preparation including curing conditions.
- Date and time of testing.
- Sample dimensions.
- Complete test results including load, sketches or pictures of samples before and after testing, and any unusual occurrences observed.
- Name of laboratory and technician performing the tests.
- Nozzle operator's experience and training. If more than one nozzle operator is used, each operator shall perform a set of test panels for each mix design proposed. Only nozzlemen with a test panel mean core grade less than or equal to 2.5 (as determined from the requirements given in ACI 506.2) will be allowed to place shotcrete.

The Engineer will inform the Contractor of the approval of the mix design and proposed placement equipment and procedures after an evaluation of the submittal that is made to the Materials and Tests Engineer.

(f) Weather.

The placement of the shotcrete shall be stopped if:

- The wind is detrimental to the placement of the shotcrete;
- The air temperature is below 40 ºF or above 90 ºF;
- Rain or lightning are present.

(g) Time Limit for Placing Shotcrete.

The placement of dry-mix shotcrete shall begin within 45 minutes of the beginning of the mix production. A new batch of shotcrete shall be produced if placement does not begin within 45 minutes or if placement is not continuous.

The placement of wet-mix shotcrete shall begin within 60 minutes after batching. A new batch of shotcrete shall be produced if placement does not begin within 45 minutes or if placement is not continuous.

(h) Thickness of Layers and Time Between Placements of Layers.

Shotcrete shall be placed in one continuous lift thickness up to a maximum lift thickness of 6 inches. For shotcrete layer thicknesses greater than 6 inches, shotcrete shall be placed in lift thicknesses equal to one half the required thickness but no more than 6 inches per lift.

If more than one lift is required there shall be a delay of time between the placement of each lift. The delay shall be until the initial set of the shotcrete. The initial set shall be defined as the point in time when the shotcrete has reached a compressive strength of 500 psi.

The determination of initial set will be done by the Engineer using a penetrometer in accordance with the requirements given in AASHTO T 197, "Time of Setting of Concrete Mixtures by Penetration Resistance". The Contractor shall furnish a penetrometer that is determined by the Engineer to be adequate for measuring the compressive strength. The Engineer shall have exclusive possession and use of the penetrometer beginning at least 5 calendar days before the start of shotcrete placement. The penetrometer will be returned to the Contractor when shotcrete placement is completed.

At the point in time when the initial set is achieved, the surface shall be lightly broomed to remove laitance to provide an adequate bond with the next application of shotcrete.

The Engineer will also determine when the shotcrete has taken a final set and remedial actions shall be taken by the Contractor to insure a bonding of subsequent layers of shotcrete.

(i) Construction Joints.

Boards or other solid materials shall be installed to provide the construction joints. The solid joint materials shall be removed and the joints shall be thoroughly cleaned before additional shotcrete is placed at the joint.

(j) Curing.

Two methods will be allowed for curing. The first method of curing is by keeping the surface of the shotcrete continually moist for at least 7 days by burlap that is kept wet. The second method of curing is by using an impervious membrane (curing compound) meeting the requirements given in Section 830.

(k) Surface Finish.

1. Retaining Walls.

The final surface of the shotcrete shall be finished to an even plane. The surface shall be finished to within 1/2 inch in 10 feet as measured by placing a straightedge anywhere on the surface of the shotcrete.

All metal construction materials such as guide wires and tie wires that protrude through the surface shall be removed from the surface by breaking back the protrusion and patching the flaw with cement mortar as directed by the Engineer.

The shotcrete wall shall be finished with a slight chamfer at the exterior edges of the wall.

Any additional surface finishing requirements will be shown on the plans.

2. Rock Face Protection.

The shotcrete surface shall be left in the natural shotcrete gun finish.

(l) Drainage

If draining of water from behind the shotcrete is required the details of the drainage system will be shown on the plans.

(m) Cleaning Excessive Shotcrete.

The excessive placement of shotcrete shall be continuously removed to protect the adjacent areas and keep the prior placement of shotcrete clean. "Rebound" shotcrete shall be promptly removed from the work area.

(n) Defective Work.

Areas of defective work shall be replaced. The Contractor shall submit a written replacement procedure to the Engineer for review prior to making the repair. All repair work shall be performed without additional compensation.

(o) Shotcrete Production Report.

The Contractor shall submit a written report of the shotcrete production and application to the Engineer within 24 hours of the completion of shotcrete application. The following shall be included in the report:

- Quantity and location of shotcrete applied including sketches of areas where shotcrete was placed;
- Observations of success or problems of equipment operation, application, final condition, and any other relevant issues encountered during production and application;
- The batch number of the shotcrete;
- Name of nozzleman;
- Name and signature of the Contractor's supervisor performing the observation.

(p) Test Panels, Coring And Testing During Production Placement.

The Contractor shall produce a test panel in accordance with the requirements given in ASTM C 1140 for each work day or every 50 cubic yards of shotcrete placed, whichever is less. Test panels shall be kept moist at all times. The panels shall be kept between 60 º F to 80 º F for the first 24 to 48 hours before they are moved to the testing laboratory for standard curing. Five cores for compressive strength test specimens shall be obtained from each panel and shall be tested in accordance with the requirements given in AASHTO T 24. Two samples shall be tested at 7 days and three at 28 days. Test reports shall be forwarded to the Engineer within 24 hours after testing. Cores for testing shall be obtained from the panels no more than 2 hours before testing. It shall be the responsibility of the Contractor to retain a testing laboratory, approved by the Department, to perform these tests.

571.04 Method of Measurement.

Shotcrete may be measured as a part of other items of work. A separate quantity of shotcrete will not be given when it is included in other items of work.

When direct payment is made for shotcrete it will be measured in units of square yards at the surface of the shotcrete placement. The square yardage will be limited to the actual number of square yards placed within lines shown on the plans, or designated by the Engineer, that define the plan limits of the required shotcrete placement. All portions of shotcrete placed outside the limits of measurement will be considered incidental to the placement of the shotcrete.

571.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for shotcrete shall be full compensation for all materials, equipment tools, labor, testing and incidentals required to complete this item of work. The contract unit price includes preparation of the surface to be treated, furnishing and installation of wire reinforcement and anchor bolts and the furnishing and installing the materials required for drainage and final surface finishing.

(b) Payment will be made under Item No.:

571-A Shotcrete __*__ inches Thick - per square yard

SECTION 572
SOLDIER PILE RETAINING WALL

572.01 Description.

The work of this Section shall cover designing and constructing a soldier pile retaining wall with permanent ground anchors consisting of steel piles and lagging. The soil and rock behind the wall shall be retained by lagging set in the pile flanges.

572.02 Materials.

(a) Steel Piles.

Steel piles shall meet the requirements given in Section 834.

(b) Structural and Reinforcing Steel.

Structural steel shall meet the requirements given in Section 836.

Reinforcing steel shall meet the requirements given in Section 835.

(c) Concrete for Anchoring Piles in Drilled Holes.

Concrete for anchoring piles in drilled holes shall meet the requirements given in Section 501 for Class A concrete.

(d) Grout

1. Low Strength Cement Mortar for Stabilizing Drilled Holes.

   Low strength cement mortar shall meet the requirements given in Section 260 for Cement Mortar Flowable Backfill, Mix 2.

2. Grout for Ground Anchors.

   The grout shall be a neat cement or sand/cement grout. The Contractor shall submit the proposed grout mix design to the Materials and Tests Engineer for approval no later than 30 calendar

days prior to production. The Contractor shall make arrangements for an ALDOT approved testing laboratory to test the proposed grout mix design. The mix design shall include the following:

- A list of all the materials used in the design of the mix with the source and vendor code indicated.
- Compressive strength test results verifying that the proposed mix design will have a minimum compressive strength of 1500 psi at 3 days, and a minimum compressive strength of 3000 psi at 28 days. Compressive strength shall be tested in accordance with the requirements given in AASHTO T 106, "*Compressive Strength of Hydraulic Cement Mortar (Using 50 mm or 2 inch Specimens)*".

Test results for the proposed grout mix that have been completed within one year of the start of work, and that have been performed by an ALDOT approved testing laboratory, may be submitted for verification of the mix design.

(e) Lagging.

All lagging for the wall facing shall meet the requirements given in Section 833 and Section 834 for Timber and Steel piles respectively. Timber lagging shall be a minimum of 3 inches thick. Steel piling size shall be as designated on the plans.

(f) Ground Anchors.

1. Ground anchors shall conform to the following requirements:

    - All materials for ground anchors shall comply with the current "Recommendations for Prestressed Rock and Soil Anchors" from the Post-Tensioning Institute (PTI).
    - Tie back tendons shall be fabricated from prestressing steel meeting the requirements given in Section 835.
    - The Contractor shall provide “Class 1” corrosion protection (double corrosion protection) for all ground anchors in accordance with the "Recommendations for Prestressed Rock and Soil Anchors" from the Post-Tensioning Institute.

2. Corrosion protection for the tieback tendons shall be fabricated from the following:

Corrosion-inhibiting grease shall conform to the requirements of Section 3.2.5 of the PTI "Specification for Unbonded Single Strand Tendons."

The bondbreaker for strand tendon unbonded length shall be:

- A polyethylene tube pulled or pushed over a strand. The polyethylene shall be Type II, III or IV as defined by ASTM D-1248 (or approved equal). The tubing shall have a minimum wall thickness of 60 mils +/- 10 mils; or
- A hot-melt extruded polypropylene tube applied over a corrosion inhibiting grease coated strand. The polypropylene shall be cell classification PP 210 B5554211, as defined by ASTM D-4101 (or approved equal). The tubing shall have a minimum wall thickness of 60 mils +/- 10 mils; or
- A hot-melt extruded polyethylene tube applied over a corrosion inhibiting grease coated strand. The polyethylene shall be high density Type III as defined by ASTM D-3350 and ASTM D-1248 (or approved equal). The tubing shall have a minimum wall thickness of 60 mils +/-10 mils.

3. The bondbreaker for bar anchor unbonded length shall be a low density polyethylene tubing, polypropylene tubing or polyvinyl chloride tubing with a minimum wall thickness of 40 mils +/- 10 mils.
4. Corrugated tubes shall be:
    a. High density corrugated polyethylene tubing conforming to the requirement of AASHTO M 252 with a minimum wall thickness of 30 mils; or
    b. Corrugated polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D-1784, Class 13464-8; or
    c. Deformed steel tubing or pipes with a minimum wall thickness of 25 mils.

5. Fusion bonded, epoxy coating shall be in accordance with AASHTO M284, except that it shall have a film thickness of 15 mils.
6. Heat-shrink tubing shall be an irradiated, heat shrinkable polyethylene tube internally coated with a thixotropic sealant. Prior to shrinking the tube shall have a nominal wall thickness of 24 mils. The adhesive sealant inside the tube shall have a nominal thickness of 20 mils.
7. A trumpet shall be used to provide a transition from the anchorage to the unbonded length corrosion protection and shall be fabricated from a steel pipe or tube conforming to the requirements of ASTM A-53 for pipe or ASTM A-500 for tubing.
8. The trumpet shall have a minimum wall thickness of 0.125 inches for diameters up to 4 inches and 0.20 inches for larger diameters.

(g) Wall Drainage System.

The wall drainage system shall meet the requirements given in the working drawings.

(h) Concrete Fascia Panels.

Precast concrete fascia panels shall meet the requirements as given in Section 831. Concrete for cast in place fascia panels shall meet the requirements as given in Section 501 for Class A concrete.

572.03 Design Requirements and Submittals

(a) Design Requirements for Soldier Pile Wall with Permanent Ground Anchors.

The design for the soldier pile retaining wall shall be in accordance with the plans and the latest edition of the AASHTO "LRFD Bridge Design Specifications" with interims, and the "Recommendations for Prestressed Rock and Soil Anchors" from the Post-Tensioning Institute. The design shall be based on the wall layout, locations, cross sections, soil borings, and ground water information as shown in the plans. A copy of the geotechnical investigation report can be provided upon request. The design shall consider the internal and global stability of the wall system. The overall stability of the earth mass being retained shall be checked and shall have a minimum factor of safety of 1.3. The maximum allowed bond length shall not exceed 40 feet unless otherwise approved by the State Geotechnical Engineer. The Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this Article.

(b) Working Drawings for Soldier Pile Wall with Permanent Ground Anchors.

The Contractor shall submit Working Drawings of the solider pile and lagging system. Include details of the following:

- Details of the soldier piles and a description of their installation method,
- Details of the lagging and a description of their installation method, and
- Details of the connections and anchorage system of the tie back anchors to the soldier piles.
- Details for the construction of drainage facilities associated with the soldier pile and lagging retaining walls shall be clearly indicated.

The Contractor shall submit Working Drawings of the ground anchor tendon and the corrosion protection system. Include details of the following:

- Spacers and their location
- Centralizers and their location
- Unbonded length corrosion protection system, including the permanent rubber seal between the trumpet and the tendon unbonded length corrosion protection.
- Bond length corrosion protection system
- Anchorage and trumpet
- Anchorage corrosion protection system
- Anchors using non-restressable anchorage device

The Contractor shall submit the proposed method to be followed for the permanent ground anchor testing. This submittal shall include all necessary drawings and details to clearly describe the method proposed.

(c) Ground Anchor Construction Procedure and Schedule.

The Contractor shall submit with the Working Drawings a detailed description of the construction procedure proposed for use. A description of the tie back installation including drilling procedures, grout mix design and placement method, and stressing information shall be included. The Contractor shall also submit the methods and materials used in filling the annulus over the unbonded length of the anchor and a description of any temporary supports needed to support the soldier pile and lagging wall until the tie back anchors have been installed and loaded to the design load.

The Contractor shall submit a ground anchor schedule giving:

- Ground anchor number
- Ground anchor factored design load
- Type and size of tendon
- Minimum total bond length
- Minimum anchor length
- Minimum tendon bond length
- Minimum unbonded length.

The Contractor shall also submit a profile view indicating the elevation at the top of the wall, the elevation at the bottom of the wall, all horizontal and vertical break points and showing tie back anchor identification number, and a plan view of the wall indicating the offset from the construction centerline to the face of the wall at all changes in horizontal alignment.

(d) Working Drawings for Concrete Fascia Panels.

The Contractor shall submit working drawings for the concrete fascia panels, in accordance with the requirements given in Article 105.02, to the Engineer for approval. Concrete fascia panels may be precast, cast in place, or as shown in the plans.

If cast-in-place concrete fascia is used the following requirements apply.

1. Where the lateral pressure from concrete placement is less than or equal to the design earth pressure, the Contractor may tie forms directly to the soldier piles.

2. Where the lateral pressure from concrete placement is greater than the design earth pressure, the Contractor shall follow one of the following procedures:

a. Tie the forms to strongbacks behind the lagging, or use some other system that confines the pressure from concrete placement between the lagging and the form panels, in addition to the ties to the soldier piles.

b. Reduce the rate of placing concrete to reduce the pressure from concrete placement to less than or equal to the design earth pressure in addition to the ties to the soldier piles.

c. Follow a procedure with a combination of a. and b.

3. The Contractor shall design the forms for an appropriate rate of placing concrete so that no cold joints occur, considering the wall thickness and height, and volume of concrete to be placed.

Precast concrete fascia when used shall be designed in accordance with current AASHTO LRFD Bridge Design Specifications for retaining wall facing elements. The contractor shall submit design calculations for panel connection and working drawings showing the proposed panel layout with construction joints, underdrains, and all utilities. The working drawings shall also detail the procedures for panel connection, erection, and any closure pours. The initial submittal of the design calculations and Working Drawings shall be sealed by a Professional Engineer licensed in the State of Alabama. Limits of the wall will be in accordance with the retaining wall layout. Slight modifications of the bottom of the wall may be allowed as necessary to accommodate precast concrete fascia design and construction.

(e) Initial Submittal of Design Calculations and Working Drawings.

The Contractor shall submit the design calculations and working drawings to the Materials and Tests Engineer as an initial submittal in accordance with the requirements given in Article 105.02 for working drawings. The initial submittal shall also identify the Contractor Qualifications requirements as given in Article 572.04. Changes in personnel will not be permitted without a written request by the Contractor. This submittal shall be made within 14 calendar days after the date of the "Notice to Proceed".

`If clarifications are required, the calculations and drawings will be returned to the Contractor with comments for clarification. The initial submittal will be returned to the Contractor for clarification within 14 calendar days after the receipt of the initial submittal.

The Contractor will be allowed 7 calendar days for each clarification of the initial submittal and the Materials and Tests Engineer will be allowed 7 calendar days to determine if further clarification is necessary.

The Materials and Tests Engineer will not approve the submittal of design calculations and Working Drawings but will review the submittal for completeness.

The initial submittal of the design calculations and Working Drawings shall be sealed by a Professional Engineer licensed in the State of Alabama.

(f) Final Submittal of Design Calculations and Working Drawings.

When the Materials and Tests Engineer informs the Contractor that the design calculations and Working Drawings are complete, the Contractor shall make a final submittal in accordance with the requirements given in Article 105.02. The Contractor will be allowed 5 calendar days to make the final submittal.

The Contractor shall not begin wall construction or incorporate materials into the work until the Materials and Tests Engineer returns one set of the completed design calculations and Wall Construction Drawings to the Contractor.

The final submittal of the design calculations and Wall Construction Drawings shall be sealed by a Professional Engineer licensed in the State of Alabama.

572.04 Contractor Experience Requirements.

The Contractor or Subcontractor performing this work shall have installed permanent ground anchors for a minimum of three (3) years. Prior to the beginning of construction, the Contractor shall submit a list containing at least five (5) projects on which the Contractor has installed permanent ground anchors. A brief description of each project and a reference shall be included for each project listed. As a minimum, the reference shall include an individual's name and current phone number.

The Contractor shall assign an engineer to supervise the work with at least three (3) years of experience in the design and construction of permanently anchored Structures. The Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this Article. Drill operators and on-site supervisors shall have a minimum of 1 year experience installing permanent ground anchors.

The Contractor shall allow up to 15 calendar days for the Engineer's review of the qualifications and staff as noted above. Work shall not be started on any anchored wall system nor materials ordered until written approval of the Contractor's qualifications is given.

572.05 Construction Requirements.

(a) Preconstruction Conference.

A permanent ground anchor preconstruction conference, to discuss construction procedures, personnel, and equipment to be used, shall be held at least 5 working days prior to the Contractor beginning any permanent ground anchor work at the site. The list of materials for this item of Work will also be discussed. Those attending shall include:

1. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of drilling the ground anchor holes, placing the permanent ground anchors and grout, and tensioning and testing the permanent ground anchor.
2. (representing the Department) The Project Engineer, key inspection personnel, and representatives from Materials and Tests.

(b) Installation of Soldier Piles.

The Contractor shall either drive piles or excavate holes for the placement of the soldier piles, concrete and flowable fill. Piles installed by driving shall be installed in accordance with the requirements given in Section 505. The location and alignment of the soldier piles shall be in accordance with the working drawings. The Contractor shall be fully responsible for all costs for replacing misaligned piles and lagging that will not properly fit into the flanges of the soldier piles.

For soldier piles installed in excavated holes the Contractor shall use equipment that will drill through soil, rock, boulders and debris that may be encountered during drilling. Blasting is not permitted to advance excavations. Blasting for rock core removal may be allowed upon written approval of the Materials and Tests Engineer. The Contractor shall provide the means and materials necessary

to keep the sides of the excavated holes from collapsing. Casing drilling mud shall be used to stabilize a hole if it is unstable.

During construction the Contractor shall control drainage in the vicinity of the soldier pile wall. The Contractor shall direct run off away from the soldier pile wall and areas above and behind the wall.

A soldier pile shall be installed with a minimum clearance of 3 inches within the excavated hole and shall be within 1.5 inches of the horizontal location shown on the working drawings. The installed soldier pile shall be vertical within a tolerance of 1 %.

A soldier pile shall be installed in the drilled hole and braced against movement prior to the final placement of the concrete. A maximum of 2 feet of concrete may be placed in the drilled hole prior to the final placement of concrete to help stabilize the pile during final placement of the concrete. The pile shall be centered in the hole so that there is uniform coverage of concrete around the pile.

Concrete shall be placed through a tremie to the bottom of the hole if drilling mud is used to stabilize the excavation.

(c) Excavation of the Soil in front of the Wall.

The Contractor shall perform the excavation using procedures that prevent ground loss, swelling, and loosening of the soil that will be retained by the wall. Concrete and flowable fill placed in the holes to brace the soldier piles shall be cured a minimum of 7 days before beginning excavation at the face of the wall. The Contractor shall excavate in lifts not to exceed 5 feet in height.

If the excavation face becomes unstable at any time, the Contractor shall suspend soldier pile wall construction and temporarily stabilize the face by immediately placing an earth berm against the unstable face. Soldier pile wall construction may not proceed until remedial measures are proposed by the Contractor and accepted by the Engineer.

All drainage materials shall be installed in accordance with the working drawings.

(d) Ground Anchor Fabrication.

Ground anchors may be either shop or field fabricated. Ground anchors shall be fabricated as shown on the approved Working Drawings.

The Contractor shall select the type of tendon to be used. The tendon shall be sized so the factored design load does not exceed 80 percent of the minimum guaranteed ultimate tensile strength of the tendon. In addition, the tendon shall be sized so the maximum test load does not exceed 80 percent of the minimum guaranteed ultimate tensile strength of the tendon.

The Contractor shall be responsible for determining the bond length and tendon bond length necessary to develop the factored design load indicated in the Plans in accordance with Item 572.05(g)1 and Item 572.05(g)2. The minimum bond length shall be 10 feet in rock and 15 feet in soil.

The tendon bond length portion of the tendon shall be corrosion protected by encapsulating the tendon in a grout-filled corrugated tubes. The tendons can be grouted inside the encapsulation prior to inserting the tendon in the drill hole or after the tendon has been placed in the drill hole. Expansive admixtures can be mixed with the encapsulation grout if the tendon is grouted inside the encapsulation while outside the drill hole. The tendon shall be centralized within the bond length encapsulation with a minimum of 0.20 inches of grout cover. Spacers shall be used along the tendon bond length of multi-element tendons to separate the elements of the tendon so the prestressing steel will bond to the encapsulation grout.

Centralizers shall be used to provide a minimum of 0.5 inches of grout cover over the tendon bond length encapsulation. Centralizers shall be securely attached to the encapsulation and the center-to-center spacing shall not exceed 10 feet. In addition, the upper centralizer shall be located a maximum of 5 feet from the top of the tendon bond length and the lower centralizer shall be located a maximum of 1 foot from the bottom of the tendon bond length.

The centralizer shall be able to support the tendon in the drill hole and position the tendon so that a minimum of 0.5 inches of grout cover is provided and shall permit free flow of grout.

Centralizers are not required on encapsulated, pressure-injected ground anchor tendons if the ground anchor is installed in coarse grained soils (more than 50 percent of the soil larger than the number 200 sieve) using grouting pressures greater than 150 psi.

Centralizers are not required on encapsulated, hollow-stem-augered ground anchor tendons if the ground anchor is grouted through and the hole is maintained full of a stiff grout (8-inch slump or less) during extraction of the auger.

The minimum unbonded length of the tendon shall be 15 feet or as shown in the Plans.

Corrosion protection of the unbonded length shall be provided by a sheath completely filled with corrosion inhibiting grease or grout. If grease is used under the sheath, provisions shall be made to

prevent the grease from escaping at the ends of the sheath. The grease shall completely coat the tendon and fill the voids between the tendon and the sheath. The Working Drawings shall show how the Contractor will provide a transition between the tendon bond length and the unbonded tendon length corrosion protection.

If the sheath is not fabricated from a smooth tube, a separate bond breaker shall be provided. The bond breaker shall prevent the tendon from bonding to the anchor grout surrounding the tendon unbonded length.

The total anchor length shall not be less than that indicated in the Plans or the approved Working Drawings.

Anchorage devices shall be capable of developing 95 percent of the minimum guaranteed ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1 of the Post Tensioning Institute, "Specification for Unbonded Single Strand Tendons, First Edition – 1993."

Non-restressable anchorage devices may be used except where indicated in the Plans.

Restressable anchorages shall be provided on those ground anchors that require reloading. The post-tensioning supplier shall provide a restressable anchorage compatible with the post-tensioning system provided.

The bearing plates shall be sized so the bending stresses in the plate do not exceed the yield strength of the steel when a load equal to 95 percent of the minimum guaranteed ultimate tensile strength of the tendon is applied, and the average bearing stress on the concrete does not exceed that recommended in Section 3.1.3 of the Post Tensioning Institute, "Specification for Unbonded Single Strand Tendons, First Edition – 1993."

The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate. The trumpet shall be long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, the trumpet shall be long enough to enable the tendon to make a transition from the diameter or the tendon in the unbonded length to the diameter of the tendon at the anchor head without damaging the encapsulation. Trumpets filled with corrosion-inhibiting grease shall have a permanent rubber seal, as approved by the Engineer, provided between the trumpet and the tendon unbonded length corrosion protection. Trumpets filled with grout shall have a temporary seal provided between the trumpet and the tendon unbonded length corrosion protection or the trumpet shall overlap the tendon unbonded length corrosion protection.

(e) Tendon Storage and Handling.

Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, and deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer will reject the affected tendons.

The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Engineer will examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Engineer, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations and as approved by the Engineer. If, in the opinion of the Engineer, the smooth sheathing has been damaged, the Contractor shall repair it with ultra high molecular weight polyethylene (PE) tape. The tape shall be spiral wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

(f) Installing Permanent Ground Anchors.

The Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the ground anchor.

When caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use a temporary casing. The Contractor's method to prevent ground movement shall be approved by the Engineer. The casings for the anchor holes, if used, shall be removed. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. The ground anchor shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported Structure. At the point of entry the ground anchor shall be installed within plus or minus 3 degrees of the inclination from horizontal shown in the Plans or the approved Working Drawings.

The tendon shall be inserted into the drill hole to the desired depth. When the tendon cannot be completely inserted without difficulty, the Contractor shall remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

The grout equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge near the discharge end to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout.

The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in soils or fracturing of rock formations.

After grouting, the tendon shall not be loaded for a minimum of 3 days.

No grout shall be placed above the top of the bond length during the time the bond length grout is placed. The grout at the top of the drill hole shall not contact the back of the Structure or the bottom of the trumpet. Except as otherwise noted, only nonstructural filler shall be placed above the bond length grout prior to testing and acceptance of the anchor. The Contractor may place structural grout above the bond length grout prior to testing and acceptance of the anchor subject to the following conditions:

1. The anchor unbonded length shall be increased by 8 feet minimum.
2. The grout in the unbonded zone shall not be placed by pressure grouting methods.

The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 1 foot into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

The corrosion protection surrounding the no load zone length of the tendon shown in the Plans shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

The bearing plate and anchor head shall be placed so the axis of the tendon and the drill hole are both perpendicular to the bearing plate within plus or minus 3 degrees and the axis of the tendon passes through the center of the bearing plate at the intersection of the trumpet and the bearing plate when fully seated with the alignment load.

The trumpet shall be completely filled with corrosion inhibiting grease or grout. Trumpet grease can be placed anytime during construction. Trumpet grout shall be placed after the ground anchor has been tested. The Contractor shall demonstrate to the Engineer that the procedure selected by the Contractor for placement of either grease or grout produces a completely filled trumpet.

All anchorages permanently exposed to the atmosphere shall be covered with a corrosion inhibiting grease-filled or grout-filled cover. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractor for placement of either grease or grout produces a completely filled cover. If the Plans require restressable anchorages, corrosion inhibiting grease shall be used to fill the anchorage cover and trumpet.

(g) Testing and Stressing.

Each ground anchor shall be tested. The test load shall be simultaneously applied to the entire tendon. Stressing of single elements of multi-element tendons will not be permitted. The Engineer will record test data.

The testing equipment shall consist of a dial gauge or vernier scale capable of measuring to 0.001 inch and shall be used to measure the ground anchor movement. The movement-measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length plus 1 inch. The dial gauge or vernier scale shall be aligned so that its axis is within 5 degrees from the axis of the tieback. A hydraulic jack and pump shall be used to apply the test load.

All jacks, pressure gauges, pumps and load cells shall have been calibrated with each other within the last 6 months by an independent AASHTO accredited laboratory or by a Department laboratory. Calibrated jacks, gages, pumps and load cells shall have identifiable serial numbers to insure traceability to calibration tests.

The pressure gauge shall be graduated in increments of either 100 psi or 2 percent of the maximum test load, whichever is less. The pressure gauge will be used to measure the applied load. The pressure

gauge shall be selected to place the maximum test load within the middle ⅔ of the range of the gauge. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total anchor length at the maximum test load plus 1 inch. The jack shall be independently supported and centered over the tendon so that the tendon does not carry the weight of the jack. The Contractor shall have a second calibrated jack pressure gauge at the site. Calibration data shall provide a specific reference to the jack and the pressure gauge.

The loads on the ground anchors during the performance and verification tests shall be monitored to verify consistency of load where the test load is maintained within 5% of the specified value. Performance test loads, and verification test loads when specified, sustained for 5 minutes or less, and all proof test leads, shall be monitored by the jack pressure gauge alone. Performance test loads, and verification test loads when specified, sustained for longer than 5 minutes shall be monitored with the assistance of an electric or hydraulic load cell. The Contractor shall provide the load cell and a readout device. The load cell shall be mounted between the jack and the anchor plate. The load cell shall be selected to place the maximum test load within the middle ⅔ of the range of the load cell. The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cell and stressing anchorage are in alignment.

The permanent ground anchor load monitoring procedure for performance test loads, and verification test loads, sustained for longer than 5 minutes shall be as follows:

Step 1: For each increment of load, attainment of the load shall be initially established and confirmed by the reading taken from the jack gauge.

Step 2: Once the permanent ground anchor load has been stabilized, based on the jack gauge reading, the load cell readout device shall immediately be read and recorded to establish the load cell reading to be used at this load. The load cell reading is intended only as a confirmation of a stable permanent ground anchor load, and shall not be taken as the actual load on the permanent ground anchor.

Step 3: During the time period that the load on the permanent ground anchor is held at this load increment, the Contractor shall monitor the load cell reading. The Contractor shall adjust the jack pressure as necessary to maintain the initial load cell reading. Jack pressure adjustment for any other reason will not be allowed.

Step 4: Permanent ground anchor elongation measurements shall be taken at each load increment as specified in Item 572.05(g)1.

Step 5: Steps 1 through 4 shall be repeated at each increment of load, in accordance with the load sequence specified in Item 572.05(g)1.

1. Performance Testing.

Performance tests shall be done in accordance with the following procedures. Five percent of the ground anchors and at any other locations as determined by the Engineer shall be performance tested. The Engineer will select the ground anchors to be performance tested. The initial three production anchors shall be performance tested.

The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the following schedule, consistent with the Contractor design. The load shall be raised from one increment to another immediately after a deflection reading.

PERFORMANCE TEST SCHEDULE

INCREMENT	LOAD	INCREMENT	LOAD
1	AL	15	AL
2	0.25DL *	16	0.25DL
3	AL	17	0.50DL
4	0.25DL	18	0.75DL
5	0.50DL	19	1.00DL
6	AL	20	1.20DL *
7	0.25DL	21	AL
8	0.50DL	22	0.25DL
9	0.75DL *	23	0.50DL
10	AL	24	0.75DL
11	0.25DL	25	1.00DL
12	0.50DL	26	1.20DL
13	0.75 DL	27	1.33DL *
14	1.00DL *	28	REDUCE TO LOCK-OFF LOAD

Where:
AL – is the alignment load
DL – is the tie back anchor design load

The maximum test load in a performance test shall be held for 10 minutes. The load-hold period shall start as soon as the maximum test load is applied and the anchor movement, with respect to a fixed reference, shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the anchor movement between 1 and 10 minutes exceeds 0.04 inches, the maximum test load shall be held for an additional 50 minutes. If the load-hold is extended, the anchor movement shall be recorded at 20, 30, 40, 50, and 60 minutes. If an anchor fails in creep, retesting will not be allowed. All anchors not performance tested shall be proof tested.

2. Proof Testing.

Proof tests shall be performed by incrementally loading the ground anchor in accordance with the following schedule, consistent with the Contractor's design. The load shall be raised from one increment to another immediately after a deflection reading. The anchor movement shall be measured and recorded to the nearest 0.001 inches with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with a pressure gauge. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Proof Test Schedule
Load
AL
0.25 DL
0.50 DL
0.75 DL
1.00 DL
1.2 DL
1.33 DL
AL
Jack to lock-off load
Where: AL – is the alignment load DL – is the design load

The maximum test load in a proof test shall be held for 10 minutes. The load-hold period shall start as soon as the maximum test load is applied and the anchor movement with respect to a fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the anchor movement between 1 and 10 minutes exceeds 0.04 inches, the maximum test load shall be held of an additional 50 minutes. If the load-hold is extended, the anchor movements shall be recorded at 20, 30, 40, 50, and 60 minutes. If an anchor fails in creep, retesting will not be allowed.

(h) Permanent Ground Anchor Acceptance Criteria.

A performance or proof tested ground anchor with a 10-minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with less than 0.04 inches of movement between 1 and 10 minutes; and
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

A verification, performance or proof tested ground anchor with a 60-minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with a creep rate that does not exceed 0.08 inches/log cycle of time and is a linear or decreasing creep rate.
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

If the total movement of the ground anchors at the maximum test load does not exceed 80 percent of the theoretical elastic elongation of the tendon unbonded length, the Contractor shall replace the ground anchor at no additional cost to the Department. Retesting of a ground anchor will not be allowed.

Ground anchors that have a creep rate greater than 0.08 inches/log cycle of time can be incorporated in the finished Work at a load equal to ½ its failure load. The failure load is the load carried by the anchor after the load has been allowed to stabilize for 10 minutes.

When a ground anchor fails, the Contractor shall modify the design, the construction procedures, or both. These modifications may include, but are not limited to, installing replacement ground anchors, modifying the installation methods, increasing the bond length or changing the ground anchor type. Any modification that requires changes to the Structure shall have prior approval of the Engineer. Any modifications of design or construction procedures shall be at the Contractor's expense.

Upon completion of the test, the load shall be adjusted to the lock-off load indicated in the Plans and transferred to the anchorage device. The ground anchor may be completely unloaded prior to lock-off. After transferring the load and prior to removing the jack a lift-off reading shall be made. The lift-off reading shall be within 10 percent of the specified lock-off load.

572.06 Method of Measurement.

The Soldier Pile Retaining Wall will be measured in units of square yards or square feet of the exposed face of the wall as designated in the plans. If the working drawings show vertical and horizontal limits that are less than what is shown on the plans, then the measurement will be made on the limits shown on the working drawings.

572.07 Basis of Payment.

(a) Unit Price Coverage.

The Soldier Pile Retaining Wall will be paid for at the contract unit price. This payment shall be full compensation for all labor, equipment, tools, materials (concrete, flowable backfill, reinforcing steel, piling, structural steel, drainage, etc.) and incidentals necessary to completely construct and remove the wall.

The Soldier Pile Retaining Wall with Permanent Ground Anchors will be paid for at the contract unit price. This payment shall be full compensation for all submittals, labor, equipment, tools, materials (concrete, flowable backfill, reinforcing steel, piling, structural steel, drainage, etc.), material tests, field tests and incidentals necessary to acceptably fabricate and test the wall components and construct the wall. This payment shall also be full compensation for furnishing and placing the reinforcing steel for the wall facing.

Excavation will be covered under other items of work.

(b) Payment will be made under Item No.:

572-A Soldier Pile Retaining Wall, * , **- per square yard

572-B Soldier Pile Retaining Wall, * , **– per square feet
* “Temporary”, “Permanent”, or “with Permanent Ground Anchors”
** Wall Identification, if required. (i.e. Number 1, Number 2, etc.)

SECTION 573
AGGREGATE FOUNDATIONS

573.01 Description.

This work shall consist of designing and constructing aggregate foundations at the locations shown on the Plans. The aggregate foundations are also referred to as either "stone column" foundations or "compacted aggregate" foundations.

573.02 Materials.

Unless approved otherwise by the Engineer, the aggregate for aggregate foundations shall be Number 410 coarse aggregate meeting the requirements given in Section 801.

573.03 Design Requirements for Aggregate Foundations.

The Contractor shall be responsible for insuring that the size, pattern, and spacing of the aggregate foundations are adequate to provide the required bearing capacity, settlement control, and global slope stability. The Contractor shall be fully responsible for all assumptions made about the strength of the soil and rock and all implications that the properties of the soil and rock have on the design, constructability and stability.

The design of the aggregate foundations shall meet the requirements given in the AASHTO Standard Specifications for Highway Bridges. These requirements shall include the following:

1. A minimum factor of safety of 1.3 against global slope stability failure as outlined in FHWA Manual FHWA-SA-98-086R;
2. A minimum factor of safety of 1.5 against sliding failure;
3. The theoretical settlement shall not exceed two inches as measured from the retaining wall bearing elevation;
4. A minimum factor of safety of 3.0 against bearing capacity failure.

573.04 Submittal of Designs, Details and Construction Procedures.

(a) Initial Submittal.

The Contractor shall submit 3 sets of design calculations, foundations details and construction procedures to the Engineer as an initial submittal. This submittal shall be made within 30 calendar days after the date of the "Notice to Proceed".

If clarifications are required, one set will be returned to the Contractor with comments for clarification. The initial submittal will be returned to the Contractor for clarification within 14 calendar days after the receipt of the initial submittal.

The Contractor will be allowed 10 calendar days for each clarification of the initial submittal and the Engineer will be allowed 10 calendar days to determine if further clarification is necessary.

The Engineer will not approve the submittal of the design calculations, foundations details and construction procedures but will review the submittal for completeness.

The initial submittal of the design calculations, foundations details and construction procedures shall be sealed by a Licensed Professional Engineer licensed in the State of Alabama.

(b) Final Submittal.

When the Engineer informs the Contractor that the design calculations, foundations details and construction procedures are complete, the Contractor shall submit 5 sets of calculations and drawings and a Mylar sepia set of the drawings as a final submittal. The Contractor will be allowed 5 calendar days to make the final submittal.

The Contractor shall not begin foundation construction or incorporate materials into the work until the Engineer returns one set of the completed design calculations, foundations details and construction procedures to the Contractor.

This final submittal shall be sealed by a Licensed Professional Engineer licensed in the State of Alabama.

(c) Minimum Requirements for the Submittal of Design Calculations.

1. Configuration of the Design Submittal.

The design calculation sheets shall have the project number, foundation locations, initials of preparer, and page number at the top of each page. An index page shall be included to provide a list of the pages of the design calculations.

The design calculations shall include an explanation of all symbols on the calculations, a description of computer programs used in the design, and at least one hand calculation documenting the computer program results. The design calculations shall indicate the target minimum replacement ratio at each section.

2. Diagrams of the Critical Cross Sections.

The design calculations shall include diagrams of the critical design cross section geometry including soil and rock strata and the location, size and depth of the foundations. The design cross sections shall also include the critical slip surface shown where it will result in the minimum factor of safety.

3. Physical Properties of the Rock and Soil.

The soil and rock shear strengths (friction angle and cohesion) and unit weights shall be shown for each soil and rock strata. Geotechnical data is provided in the contract documents. Supplementary geotechnical data may be available and may be obtained from the Materials and Tests Engineer. Any additional subsurface information needed to design the aggregate foundations shall be the responsibility of the Contractor.

4. Factors of Safety.

The comparison of the calculated factors of safety and the minimum required factors of safety shall be shown for the design.

(d) Minimum Requirements for the Submittal of Foundation Details.

1. Plan View of the Foundations.

A drawing of the plan view of the aggregate foundations shall be submitted. The following details shall be shown on the plan view:

- A reference baseline;
- The offset from the construction centerline or baseline to the foundations;
- Size and alignment of the foundations;
- Right-of-way and permanent or temporary construction easements limits, location of all known active and abandoned existing utilities, adjacent structures and other potential interferences.
- The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the foundations;

2. Elevation View of the Foundations.

A drawing of the elevation view of the aggregate foundations shall be submitted. The following details shall be shown on the elevation view:

- The elevation at the top and bottom of the foundations;
- Size and alignment of the foundations;
- Schematic and elevations of the structures supported by the foundations;
- The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the foundations.

(e) Minimum Requirements for the Submittal of Construction Procedures.

Construction procedures shall be submitted to identify all of the processes, equipment, tools and materials required for the construction and testing of the aggregate foundations.

A quality control plan and examples of forms proposed for the documentation of construction daily progress reports and testing shall be submitted with the construction procedures.

573.05 Approved List of Aggregate Foundation Specialty Contractors.

The following aggregate foundation design-build specialty Contractors are approved to perform the work:

- Geopier Rammed Aggregate Piers; Geopier Foundation Company; 150 Fairview Road, Suite 335; Mooresville, North Carolina 28117;

- Vibro-Pier; Hayward Baker Corporation; 515 Nine North Court Alpharetta, GA 30004.

Other aggregate foundation specialty Contractors will be given consideration for approval. Consideration for approval will be given to specialty Contractors that can provide documentation that they have successfully designed and constructed at least 3 projects in the last 3 years where the construction of permanent aggregate foundation totals at least 50 foundations.

573.06 Construction Requirements.

(a) Compliance with the Submittal of Details and Construction Procedures.

The foundation excavation, construction and testing shall be performed in accordance with the requirements shown on the submittal of foundations details and construction procedures distributed by the Engineer.

(b) Daily Progress Reports.

The Contractor shall furnish a complete and accurate record of aggregate foundation installation to the Engineer. The record shall indicate the foundation location, length, drilled diameter, average lift thickness, and final elevations of the base and top of the foundations. The record shall also indicate the type and size of the densification equipment used. The Contractor shall immediately report any unusual conditions encountered during installation to the Engineer.

(c) Excavation, Sheeting and Shoring.

Excavation shall be extended if the Engineer determines that further excavation is necessary for the removal of soft or yielding areas that may be uncovered. Sheeting and shoring may be required to protect the site of the excavation. Excavation will be paid for under other items of work (Section 210). Sheeting and shoring will also be paid for under other items of work (Section 215).

(d) Construction Tolerances.

Aggregate foundations shall be installed so that each completed foundation (column) will be continuous throughout its length. The center of the completed foundation (column) shall be within 6 inches from the required horizontal location. The vertical alignment tolerance shall be a maximum of 2 inches horizontal for every 10 feet vertical of depth. The completed aggregate foundation diameter shall not be less than 10 percent smaller than the required diameter. The top of the ground improvement provided by the aggregate foundations shall be within 6 inches of the required elevation. Aggregate foundations shall be installed in a sequence that will minimize ground heave. Any heaving shall be re-compacted or excavated as directed by the Engineer prior to wall or embankment construction and be considered incidental to aggregate foundation construction.

(e) Modulus Test.

A modulus test shall be performed to verify the performance values selected for design. A telltale shall be installed at the bottom of a test foundation so that the deflection at the bottom of the column can be measured. The modulus test shall be conducted at a location where the bottom of the column terminates in soil. Acceptable performance is when the deflection of the bottom of the foundation is no more than 20 % of the deflection at the top of the foundation at the design stress level.

ASTM D-1143 general test procedures shall be used to establish load increments, load increment duration, and load decrements.

With the exception of the load increment representing approximately 115 % of the design maximum foundation stress, all load increments shall be held for a minimum of 15 minutes, a maximum of 1 hour, and until the rate of deflection reduces to 0.01 inches per hour or less.

The load increment that represents approximately 115 % of the design maximum stress on the foundation shall be held for a minimum of 15 minutes, a maximum of 4 hours and until the rate of deflection reduces to 0.01 inches per hour or less.

A seating load equal to 5 % of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for uneven surface conditions.

The location of the modulus test will be determined by the Engineer.

(f) Bottom Stabilization Verification Test.

After completion of the construction of the bottom of the foundation, or at any time during the process of constructing the foundation a bottom stabilization verification test may be performed as required by the Engineer. These tests shall be performed when a new soil formation is encountered, at the beginning of a project to provide quantitative information on foundation stabilization, and on 10 % of production foundations.

Bottom stabilization tests shall be performed by placing a reference bar over the excavated cavity, marking the tamper shaft, applying energy to the tamper for an additional 15 seconds, and observing the downward deflection of the tamper shaft by observing the deflection of the mark on the tamper shaft.

Acceptable performance is indicated if the movement of the shaft is less than 150 % of the vertical movement measured at the bottom of the foundation during the modulus test. If the measured vertical movement exceeds 150 % of the value measured during the modulus test, added energy shall be applied to further compact the aggregate. The procedure for measuring the movement shall then be repeated. If there is still movement greater than 150 % of that achieved during the modulus test and the movement is greater than 0.5 inches, a lift of loose aggregate may be placed on top of the compacted aggregate, and the verification test may be performed on this next lift after it is densified. If there is excessive movement on this lift, another lift may be placed and tested. Movement must be limited to below 150 % of the movement determined from the modulus test before completion of 2/3 of the depth of the foundation.

573.07 Method of Measurement.

The Aggregate Foundations will be measured in units of cubic yards. The pay quantity for Aggregate Foundations shall be the volume calculated by multiplying the plan area of improvement by the average depth of the aggregate foundations installed during construction.

573.08 Basis of Payment.

(a) Unit Price Coverage.

The Aggregate Foundations will be paid for at the contract unit price. This payment shall be full compensation for all submittals, labor, equipment, tools, materials, material tests, field tests and incidentals necessary to acceptably construct the foundations.

(b) Payment will be made under Item No.:

573-A Aggregate Foundations – per cubic yard

DIVISION 600
INCIDENTALS

SECTION 600
MOBILIZATION

600.01 Description.

This Section shall cover the preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for work on the project; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

The lump sum bid for mobilization shall be so distributed among the various pay items of the contract that an overrun of a particular pay item will not adversely affect the unit price of that item.

600.02 Materials.

Not applicable.

600.03 Construction Details.

Not applicable.

600.04 Method of Measurement.

(a) Partial Payment.

Measurement of the item of Mobilization will be on a unit basis for each project or combination of projects included in a single contract. When more than one project is included in one contract, the amount of payment to be made will be based on the percent complete and amount of the entire contract, not the percent complete and amount of each individual project. Once the amount of payment is determined, based on the entire contract, this amount will then be prepared for payment on each individual project based on the percentage of the total contract of which the project is a part.

Partial Payments for mobilization are based on the amount bid for mobilization and the total original contract amount for all items of work. Payments will be made at the time, and in the amounts shown in the following schedules.

SCHEDULE OF PARTIAL PAYMENTS FOR MOBILIZATION WHEN THE CONTRACT BID PRICE FOR MOBILIZATION IS LESS THAN, OR EQUAL TO 12 % OF THE ORIGINAL CONTRACT AMOUNT (Partial Payments are a % of the Contract Amount for Mobilization)		
TIME OF PAYMENT	AMOUNT OF PAYMENT	ACCUMULATED PAYMENT
First Estimate	20 % of the Bid Price for Mobilization	20 % of the Bid Price for Mobilization
After the First Estimate and Upon Completion of 5 % of the Original Contract Amount Excluding Prior Payment for Mobilization	50 % of the Bid Price for Mobilization	70 % of the Bid Price for Mobilization
After the First Estimate and Upon Completion of 50 % of the Original Contract Amount Including Prior Payment for Mobilization	30 % of the Bid Price for Mobilization	100 % of the Bid Price for Mobilization

SCHEDULE OF PARTIAL PAYMENTS FOR MOBILIZATION WHEN THE CONTRACT BID PRICE FOR MOBILIZATION IS GREATER THAN 12 % OF THE ORIGINAL CONTRACT AMOUNT (Partial Payments are a % of the Original Contract Amount, Except the Final Payment)		
TIME OF PAYMENT	AMOUNT OF PAYMENT	ACCUMULATED PAYMENT
First Estimate	2 % of the Original Contract Amount	2 % of Total Contract Amount
After the First Estimate and Upon Completion of 5 % of the Original Contract Amount Excluding Prior Payment for Mobilization	6 % of the Original Contract Amount	8 % of Total Contract Amount
After the First Estimate and Upon Completion of 50 % of the Original Contract Amount Including Prior Payment for Mobilization	4 % of the Original Contract Amount	12 % of Total Contract Amount
At Acceptance for Maintenance per Item 105.15(c)3.	Remainder of Contract Amount for Mobilization	100 % of Contract Amount for Mobilization

The total sum of all payments shall not exceed the original contract amount bid for the item of Mobilization, regardless of the fact that the Contractor may have, for any reason, shut down his work on the project or moved equipment away from the project and then back again.

(b) When No Separate Payment is shown in the Proposal.

When the proposal does not include a separate item for Mobilization, all work and incidental costs specified as being covered under this Section shall be included for payment under the several scheduled items of the overall contract, and no separate payment will be made therefor.

600.05 Basis of Payment.

(a) Unit Price Coverage.

The item of Mobilization, measured as noted above, will be paid for at the contract lump sum price bid. Said lump sum price bid shall be full compensation for organizing and moving all labor, tools, equipment, supplies, and incidentals to the project site and for disbanding, disorganizing, and removing all labor, tools, equipment, supplies, and incidentals from the project site, regardless of number of times such moves are made, including all preconstruction costs exclusive of bidding costs.

(b) Partial Payment.

Partial payments may be made in accordance with schedule noted in Article 600.04.

(c) Payment will be made under Item No.:

600-A Mobilization - per lump sum

SECTION 601
FIELD LABORATORIES

601.01 Description.

This Section shall cover furnishing for the duration of the contract, base, soil, and structure laboratories, and asphalt and concrete plant laboratories as specified on the plans and in these Specifications.

601.02 Materials.

Laboratories and equipment furnished shall be in satisfactory usable condition, and shall be maintained in that condition throughout the contract.

601.03 Equipment.

(a) Base, Soil, and Structure Laboratories.

Laboratories for testing soil type bases, soils, structures, and similar work shall comply in all details with the requirements of Article 106.03.

(b) Asphalt and Concrete Plant Laboratories.

Asphalt and concrete plant laboratories for testing bituminous plant mixes or portland cement concrete and similar work shall comply in all respects with the requirements of Article 106.03.

601.04 Number of Laboratories Required.

The number of Base, Soil, and Structure laboratories specified in the contract is approximate only. The number actually required will depend on the scope of the Contractor's operations and may be expected to vary from the specified number. Only the number of Base, Soil, and Structure laboratories actually furnished as directed in writing will be paid for at the contract unit price, and no claim will be allowed for extra compensation on account of overrun or underrun in these items.

Each Asphalt and Concrete Plant furnishing materials to the project must have a laboratory meeting the requirements of Article 106.03 for use by the Department; however, no direct compensation will be made for these laboratories.

601.05 Method of Measurement.

Measurement will be by the unit for each Base, Soil, and Structure laboratory furnished, as directed in writing.

No measurement for payment will be made for asphalt and concrete plant laboratories.

601.06 Basis of Payment.

(a) Unit Price Coverage.

1. Base, Soil, and Structure Laboratories.

The number of laboratories, furnished as specified above, will be paid for at the contract unit price per each, which shall be payment in full for use of the laboratory and equipment; for locating, relocating on the same contract if desired, maintaining, and removing same; for furnishing utilities (water, electricity and heat); and for all equipment, tools, labor, and incidentals necessary to complete the work.

The unit price covers the use or rental of the laboratory and equipment for the duration of the contract. Laboratories ordered by the Engineer shall be furnished promptly within the time limit designated by the Engineer; failure to provide the facility when required shall be cause for the Engineer to order the work stopped until such time as the facility is furnished. Should working conditions on the project be such that a previously ordered laboratory is not needed temporarily or permanently in certain cases, the Contractor may be allowed to remove a laboratory from the project with the written permission of the Engineer. However, it shall be expressly understood that temporary removal is for the Contractor's convenience and when work progresses to the stage that the laboratory is needed, the Engineer will give written notice to return or replace the facility. The Contractor will be given 48 hours to comply with this order; failure to comply shall be cause for the Engineer to order the work stopped. In addition, any time a laboratory is away from the job site without authorization shall be deducted from the Contractor's estimate in an amount per day, equal to the unit price bid per unit divided by the number of working days or calendar days provided by the contract. Cost of the removal and return to a facility shall be classified as incidental to furnishing the laboratory and no extra compensation for such will be allowed,

Laboratory and equipment remains the property of the Contractor and shall be removed by him upon completion of the work.

2. Asphalt and Concrete Plant Laboratories.

The Contractor will be responsible for providing a satisfactory laboratory meeting the requirements of Article 106.03 for each asphalt or concrete plant supplying materials to the project. The cost of providing these laboratories shall be included in the contract items for which asphalt or concrete materials are being furnished and no direct compensation will be made.

(b) Payment will be made under Item No.:

601-A Furnishing Base, Soil, and Structure Laboratories - per each

SECTION 602
RIGHT OF WAY AND LAND SURVEY MARKERS

602.01 Description.

This Section shall cover the work of furnishing and installing markers for marking designated points on the right of way and land surveying reference points.

602.02 Materials.

Markers shall meet the requirements given in Section 831 for Precast Concrete Products. Concrete for the markers shall be Class A concrete in accordance with the requirements given in Section 501.

Reinforcing steel shall meet the requirements given in Section 502.

The type of brass and aluminum and steel for the marker caps shall be suitable for providing a permanent marker. Each marker cap shall be a single one piece casting.

602.03 Construction Requirements.

All markers shall be set in accordance with the requirements given in the "Standards of Practice for Surveying in the State of Alabama" established by the Alabama State Board of Licensure for Professional Engineers and Land Surveyors. Markers shall also be set in accordance with the details shown on the plans. All markers shall be set by a Professional Land Surveyor licensed in the State of Alabama.

Markers shall be set plumb in stable, compacted soil on a firm foundation. The space around the marker shall be backfilled with selected approved moist material, rammed in place so that the marker, when completed, will be rigid and secure in the required location and orientation.

Any marker damaged prior to final acceptance shall be replaced by the Contractor without additional compensation.

602.04 Method of Measurement.

The number of markers of the type designated, measured for payment, will be the actual number ordered, completed, and accepted.

602.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted markers will be paid for at the contract unit price bid for each type marker, ordered and placed, measured as noted above. Said unit price shall be full compensation for furnishing all materials, fabrication of the markers, installation of the markers including excavation and backfill thereof, and for all material, tools, labor, equipment, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

602-A Right of Way Markers - per each
602-B Land Survey Markers - per each
602-C Permanent Easement Markers - per each

SECTION 603
ENGINEER'S FIELD OFFICE

603.01 Description.

(a) General.

This Section shall cover the work of furnishing and maintaining or setting up a field office for the exclusive use by the Engineer during the life of the contract.

The field office shall be in reasonably close conformity with the type specified by the plans in accordance with the following type classifications:

Type	Approximate Floor Space	Number of Offices	Work Rooms	Rest Rooms	Outside Doors	Windows
1	200 square feet {19 m^2}	1	1	1	2	4
2	400 square feet {37 m^2}	2	1	2	2	6
3	600 square feet {56 m^2}	3	1	2	2	8
NOTE: Site installation of mobile offices or trailers will require the use of tie down straps in accordance with local or state requirements for mobile homes, whichever are more stringent. For used or relocated mobile offices or trailers, the Contractor shall provide and install new tie down straps meeting the above requirements.						

(b) Item 603-A, "Furnishing Type ___ Field Office".

The field office shall be available and ready for use within 15 days after the date of the "Notice to Proceed" and will be vacated by the Engineer no later than 30 days after the date of final acceptance of all work on the project. The field office shall remain the property of the Contractor. Field offices provided under this item may be a building, house, mobile office, or trailer approved by the Engineer in reasonably close conformity with these specifications.

This Section shall also cover the work of furnishing security of the field office as required in Item 603.02(a)4. Security of the field office under Pay Item No. 603-A shall be considered a subsidiary obligation of furnishing the field office. In lieu of this security requirement, when required on the plans or in the contract, the Contractor shall furnish and install a security fence around the field office. This required fence will be paid for under Pay Item No. 603-B, Furnishing Security Fence.

(c) Item 603-C, "Furnishing Type ___ Field Office (State Retained)".

The field office shall be available and ready for use within 15 days after the date of the "Notice to Proceed". The field office, along with all furnishings, facilities, and appurtenances, shall become the property of the Department upon completion of the project. Field offices may be a new mobile office or trailer approved by the Engineer and in reasonably close conformity with these specifications.

This Section shall also cover the work of furnishing and installing a new security fence around the field office when required on the plans or in the contract. This fence will be paid for under Pay Item No. 603-B. The fence shall become the property of the Department upon completion of the project.

(d) Item 603-D, "State Furnished Field Office".

This Section shall cover the work of moving and setting up a State-furnished field office. The field office shall be available and ready for use within 15 days after the date of the "Notice to Proceed". The field office (mobile office or trailer) along with all furnishings, facilities, and appurtenances, shall be relocated from its present location to a site designated by the Engineer.

This Section shall also cover the work of furnishing and installing a new security fence around the field office when required on the plans or in the contract. This fence will be paid for under Pay Item No. 603-B. The fence shall become the property of the Department upon completion of the project.

603.02 Field Office Requirements.

(a) Item 603-A.

1. Location.

A site for the location of the field office shall be arranged for and provided by the Contractor subject to the approval of the Engineer. The site shall be on or near the right of way and readily accessible by automobile over an all-weather road, with all-weather parking facilities for at least eight vehicles adjacent to the building. If no adequate site is available on the project right of way, or the Contractor selects a site off the right of way, he shall assume all expenses in connection with obtaining and leasing the site.

2. Building.

The field office building shall be separate and apart from any buildings occupied by the Contractor. The building shall be weather-tight and insulated, suitable for year-round use with heating, air conditioning, electric power, and indoor sanitary facilities (complete with lavatory and running water). Heat shall be forced hot air from a thermostat-controlled gas, oil, or electric heating unit, properly vented, and capable of furnishing sufficient heat to maintain an inside temperature of 72 °F ± 5 °F {22 °C ± 3 °C}. The air conditioning system shall be thermostat-controlled and capable of furnishing sufficient cooling to adequately maintain an inside air temperature 25 °F {14 °C} cooler than the outside temperature. Electrical outlets shall be provided on at least two walls of any office or work room and sufficient ceiling light fixtures furnished to provide a minimum of 70 footcandles

{755 lx} of light on all working surfaces. All windows shall be fitted with locking devices, hung to open and close, and fitted with screens. Outside doors shall be fitted with cylinder locks and all keys turned over to the Engineer. A closet or locker with means for locking shall be provided for storage of survey equipment. One fire extinguisher (minimum size 10# {4.5 kg} CO_2 shall be provided for each 200 square feet {19 m^2} of floor space.

The size and configuration of the working space within each office and work room of the field office shall be such as to provide room for working and movement of personnel that is acceptable to the Engineer. Ceiling height shall not be less than 7 feet {2.13 m}.

Entrance doors to restrooms shall be equipped with door locks.

3. Office Furnishings.

Office furnishings shall be supplied with the field offices in accordance with the following schedule:

Minimum Furniture	
per office	1 desk, 3 chairs
per work room	1 plan table, 1 work table (drafting), 2 stools, 3 chairs, 1 water cooler dispenser, 1 4-drawer file cabinet, 20 feet {3 m} of book shelving, 1 plan storage rack, appropriate fire extinguishers

Furniture need not be new but must be clean, sturdy, in good repair, and acceptable to the Engineer.

4. Area Security.

The Contractor shall be responsible for the security of the field office and its immediate area against vandalism and entry by unauthorized persons. Such security shall be in the form of a guard service for non-work hours or a security fence (min. 8 feet {2.4 m} high) enclosure with a 14 foot {4 m} wide, minimum, lockable gate. See Subarticle 603.01(b) for additional requirements.

(b) Item 603-C.

1. Location.

Unless shown otherwise by the plans, the site for the location of the field office shall meet the requirements of Item 603.02(a)1. above.

2. Building.

The field office building shall be separate and apart from any buildings occupied by the Contractor. The building shall be weather tight and insulated, suitable for year-round use with heating, air conditioning, electric power, and indoor sanitary facilities (complete with lavatory and running water). Heat shall be forced hot air from a thermostat-controlled heating unit, properly vented, capable of furnishing sufficient heat to maintain an inside temperature of 72 °F ± 5 °F {22 °C ± 3 °C}. The heating unit shall be a new heat pump having heating and cooling capabilities. The air conditioning system shall be thermostat-controlled and capable of furnishing sufficient cooling to adequately maintain an inside air temperature 25 °F {14 °C} cooler than the outside temperature. Electrical outlets shall be provided on at least two walls of any office or work room and sufficient ceiling light fixtures furnished to provide a minimum of 70 footcandles {755 lx} of light on all working surfaces. All windows shall be fitted with locking devices, hung to open and close and fitted with screens. Outside doors shall be fitted with cylinder locks and all keys turned over to the Engineer. A closet or locker with means for locking shall be provided for storage of survey equipment. One fire extinguisher (minimum size 10# {4.5 kg} CO_2) shall be provided for each 19 m^2 of floor space.

The size and configuration of the working space within each office and work room of the field office shall be such as to provide room for working and movement of personnel that is acceptable to the Engineer. Ceiling height shall not be less than 7 feet {2.13 m}.

Each office shall be furnished with an acceptable set of steps for each outside door. A 6 foot by 6 foot {2 m x 2m} deck shall be provided at the top of each set of steps. Such steps and decks shall be safe, sturdy, and suitable for the intended purpose. They shall be constructed from 2 inch {50 mm} (nominal size) thick lumber treated with a timber preservative in accordance with Section 833.

All restrooms shall be vented to the outside through the use of power ventilators. Entrance doors to restrooms shall be equipped with door locks.

3. Office Furnishings.

Unless shown otherwise on the plans, office furnishings shall be supplied with the field offices in accordance with the following schedule:

Minimum Furniture	
per office	1 desk, 3 chairs
per work room	1 plan table, 1 work table (drafting), 2 stools, 3 chairs, 1 water cooler dispenser, 1 4-drawer file cabinet, 20 feet {3 m} of book shelving, 1 plan storage rack, appropriate fire extinguishers

Furniture shall be new, sturdy, and acceptable to the Engineer. Water cooler dispensers shall be UL listed, shall have a rated capacity of 8.0 gallons {3 L}, minimum, per hour of 50 °F {10 °C} water, and shall be connected to the office plumbing facilities. Any special requirement office furnishings shall be as shown on the plans.

4. Area Security.

When required, a security fence shall be installed around the office. Such security fence shall be a chain link fence, meeting the requirements of Section 871, minimum 8 feet {2.4 m} high, with a 14 foot {4 m} wide, minimum, lockable gate. See Subarticle 603.01(c) for additional requirements.

5. Project Completion.

Unless shown otherwise on the plans, the Contractor will not be required to remove the field office, its appurtenances, and security fence upon completion of the project.

(c) Item 603-D.

1. Location.

A site for the location of the field office will be arranged for by the Engineer.

2. Relocation of the Field Office.

The field office (a mobile office or trailer) along with various appurtenances (i.e., steps, decks, electric service pole, wiring from pole to office, plumbing, existing security fence, etc.) shall be moved from its present location (shown on the plans) to the location designated by the Engineer. The mobile office or trailer shall be installed with required new tie down straps and connected to utilities.

3. Decks.

If existing decks are not included with the field office to be relocated, a 6 foot by 6 foot {2 m x 2 m} minimum size deck shall be provided at the top of each set of steps by the Contractor. The decks shall be safe, sturdy, and suitable for the intended purpose constructed from 2 inch {50 mm} (nominal size) thick lumber treated with a timber preservative in accordance with Section 833.

4. Area Security.

If an existing security fence is included with the field office to be relocated, the Contractor shall remove and reinstall the fence. The cost for the existing fence relocation and its removal (if required upon completion of the project) shall be included as part of Item 603-D.

When Item 603-B is included on the plans or in the contract. the Contractor shall install a new security fence around the office. Such new security fence shall be a chain link fence, meeting the requirements of Section 871, minimum 8 feet {2.4 m} high, with a 14 feet {4 m} wide, minimum lockable gate.

5. Project Completion.

Unless shown otherwise on the plans, the Contractor will not be required to remove the field office, its appurtenances, and relocated security fence upon completion of the project.

603.03 Utilities and Services.

(a) Item 603-A.

The field office shall be provided with adequate lighting, heating, sanitary, and drinking water facilities. All installation and monthly maintenance charges for the utilities, except for the monthly telephone billing, shall be paid for by the Contractor. The Department will order service for and coordinate installation of the telephones and pay the monthly telephone billing.

Unless more stringent local or State regulations specify otherwise, sanitary facilities shall include a septic tank, min. 750 gallon {2839 L}, and adequate field lines where connection to a sanitary sewer system is unavailable.

All utility installations shall be in accordance with applicable local or State codes, ordinances, rules, and regulations.

The field office and its facilities shall be maintained in a satisfactory state of repair until released by the Engineer.

(b) Item 603-C.

The field office shall be provided with adequate lighting, heating, sanitary, drinking water, and telephone facilities. All installation charges for the utilities shall be paid for by the Contractor. The Department will pay all utility usage bills.

Unless more stringent local or State regulations specify otherwise, sanitary facilities shall include a septic tank, min. 750 gallon {2839 L}, and adequate field lines where connection to a sanitary sewer system is unavailable.

All utility installations shall be in accordance with applicable local or State codes, ordinances, rules, and regulations.

All electrical wiring shall be in accordance with applicable local or State codes, ordinances, rules, and regulations.

The field office and its facilities shall be maintained in a satisfactory state of repair throughout the life of the project.

(c) Item 603-D.

The State furnished field office will be provided with adequate electrical, sanitary, and telephone facilities. All installation charges for the utilities shall be paid for by the Contractor. The Department will pay all utility usage bills.

Unless more stringent local or State regulations specify otherwise, sanitary facilities shall include furnishing and installation of a septic tank, min. 750 gallon {2839 L}, and adequate field lines where connection to a sanitary sewer system is unavailable.

All utility installations shall be in accordance with applicable local or State codes, ordinances, rules, and regulations.

603.04 Method of Measurement.

Measurement of Field Offices will be in units of the type specified by the plans, ordered and accepted.

Measurement of the security fence will be in linear feet {meters}, to the nearest foot 0.1 foot {0.1 m}, of fence, including the gate, ordered and accepted.

603.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item No. 603-A.

The ordered and accepted Field Offices, measured as noted above, will be paid for at the contract unit price bid for the type Field Office specified, which shall be full compensation for the furnishing of the office and its related facilities, security, and services for exclusive use of the Engineer throughout the life of the contract, all as noted in this Section and the satisfactory disposal thereof after the offices are released.

No additional compensation will be allowed for furnishing field office units larger than the type specified in the contract.

Partial payments for the field offices will be made on monthly estimates in accordance with the following schedule:

a. 75% of the unit price bid upon satisfactory installation and acceptance of the facility.
b. 15% of the unit price bid when 1/2 of the anticipated construction time has expired.
c. 10% of the unit price bid when the semi-final or final estimate is paid.

2. Item No. 603-B.

The ordered and accepted security fence, measured as noted above, will be paid for at the contract unit price bid for the security fence which shall be full compensation for the furnishing and installing the fence and gate and for the maintenance of such throughout the life of the contract. The security fence, shall become the property of the Department upon completion of the project. When required on the plans, this item shall also be full compensation for removal and delivery of the fence and gates to a plan designated location.

3. Item No. 603-C.

The ordered and accepted Field Office (State Retained), measured as noted above, will be paid for at the contract unit price bid for the type Field Office specified, which shall be full compensation for the furnishing of the office, its furnishings, related facilities, appurtenances, and installations for the exclusive use of the Engineer and for the maintenance of such throughout the life of the contract. The office, along with all furnishings, facilities, and appurtenances, shall become the property of the

Department upon completion of the project. When required on the plans, this item shall also be full compensation for removal and delivery of the field office and appurtenances (including security fence) to a plan designated location.

No additional compensation will be allowed for furnishing field office units larger than the type specified in the contract.

Partial payments for the field offices will be made on monthly estimates in accordance with the following schedule:

a. 75% of the unit price bid upon satisfactory installation and acceptance of the facility.
b. 15% of the unit price bid when 1/2 of the anticipated construction time has expired.
c. 10% of the unit price bid when the semi-final or final estimate is paid.

4. Item No. 603-D.

The ordered and accepted State Furnished Field Office, measured as noted above, will be paid for at the contract unit price bid for the relocation of the Field Office specified, which shall be full compensation for the breakdown, moving, and installation of the Office, its furnishings, related facilities, and appurtenances (including existing security fence when shown on the plans). When required on the plans, this item shall also be full compensation for removal and delivery of the field office and appurtenances (including relocated security fence) to a plan designated location.

(b) Payment will be made under Item No.:

603-A Furnishing Type ___ Field Office - per each
603-B Furnishing Security Fence - per linear foot {meter}
603-C Furnishing Type ___ Field Office (State Retained) - per each
603-D State Furnished Field Office - per each

SECTION 604
GEOTEXTILES IN PERMEABLE ASPHALT TREATED BASE APPLICATION

604.01 Description.

This Section shall cover the furnishing and placing of geotextiles for use as a means to prevent clogging of the permeable base layer due to the migration of fine material from the underlying roadway layer. The geotextile shall be designed to allow passage of water while retaining untreated base or subbase course soils without clogging.

604.02 Materials.

The geotextile used in this work shall be one constructed of non-woven synthetic fibers meeting the requirements of AASHTO M 288 for Separation Geotextile Class 3 and Section 810 of these specifications with the exception that geotextiles manufactured with polyamide will not be allowed. The geotextile filter shall be resistant to the heat and temperature range expected during placement of the Permeable Asphalt Treated Base. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

604.03 Construction Requirements.

(a) General.

The surface area on which the geotextile fabric is to be placed shall be free of loose aggregate, foreign debris, and all sharp objects during placement of the fabric.

(b) Installation.

The geotextile filter shall be installed immediately prior to placement of the permeable asphalt treated base layer and extended full width between the inside and outside edge drains according to the manufacturer's specifications and as shown on the plans or in the proposal. Exposure of geotextile filter to the elements between lay down and cover shall not exceed three days.

Adjacent geotextile rolls, seamed or unseamed, shall be overlapped in the direction of placement of the Permeable Asphalt Treated Base a minimum of 2 feet {600 mm} at all longitudinal and transverse filter fabric joints.

The geotextile shall be held in place prior to Permeable Asphalt Treated Base placement by pins, staples, or other means as approved by the Engineer.

(c) Seams.

Both factory and field sewn or sealed seams, if applicable, shall conform to the strength requirements of Table 1 as outlined in AASHTO M 288 for separation applications. All seams shall be subject to the approval of the Engineer.

(d) Damage Repair.

Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. Any geotextile filter which is ripped or torn during the construction process shall be replaced or repaired with a patch which extends 3 feet {1 m} beyond the perimeter of the tear or damage.

604.04 Method of Measurement.

The geotextile will be measured by the square yard {square meter} computed from the width (from pavement edge drain to pavement edge drain) and the length as shown on the plans, or established in writing by the Engineer. This excludes seam overlaps.

604.05 Basis of Payment.

(a) General.

The accepted quantities of geotextiles will be paid for at the contract unit price per square yard {square meter} in place.

(b) Payment will be made under Item No.:

604-A Separative Geotextile - per square yard {square meter}

SECTION 605
PAVEMENT AND SPECIAL UNDERDRAIN

605.01 Description.

This Section shall cover the work of constructing pavement and special underdrain.

Pavement underdrain shall be drain lines in the median and at the edges of pavement, and shall include collection pipes, and outlets. Edge drains and median drains shall be aggregate filled underdrains.

The details of the special underdrain will be shown on the plans.

Shoulder drainage plane layers shall be constructed in accordance with the requirements given in Section 315.

Geotextile filter fabric shall be placed to reduce the movement of soil into the drains.

Pipes shall be installed to collect and provide outlets for the drainage.

605.02 Materials.

(a) Geotextile Filter.

The geotextile filter for aggregate filled underdrain shall be a non-woven material meeting the requirements of AASHTO M 288 for Class 2 Subsurface Drainage Geotextile and Section 810 of these specifications. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

(b) Pipe.

The required types and sizes of pipes will be shown on the plans.

The pipe may be of any of the non-corrugated pipe underdrain or smooth lined corrugated pipe underdrain noted in Section 852, perforated or non-perforated as required.

Pipe fittings shall be of the same material as the pipe or of a compatible material providing a crush strength equal to, or greater than, that of the type pipe being used.

(c) Aggregate Filler.

Aggregate filler shall meet the requirements for Coarse Aggregate, Section 801, for ALDOT size #4, #5, or #57 and the additional requirement that no more that 1% of the aggregate passes the No. 200 {75 μm} sieve.

(d) Slope Paving.

Slope paving for outlet headwalls shall meet the requirements noted in Section 614.

605.03 Construction Requirements.

(a) General.

The installation of pavement and special underdrain shall be done in coordination with other work to prevent damage to the roadway.

Materials from the excavation may be deposited outside the trench work area for reuse in the work. Excess material shall be removed and disposed of as shown on the plan details or as directed by the Engineer.

(b) Aggregate Filled Underdrain.

An aggregate filled underdrain shall be a trench that is lined with a geotextile filter fabric and then filled with aggregate.

Pavement median drains and edge drains shall be an aggregate filled underdrain with pipes placed as shown on the plans to collect drainage and provide a connection to the outlets for the drainage.

Exposure of geotextiles to the elements between laydown and cover shall be a maximum of 14 days to minimize the potential for damage.

The geotextile filter shall be installed in such a manner that all splice joints are provided with a minimum overlap of 3 feet {1 m}. Securing pins shall be installed to anchor the filter fabric if the filter fabric does not remain in place during the construction of the drains.

Where seams are required in the geotextile filter in the longitudinal trench direction, they shall be joined by either sewing or overlapping as outlined in Article 608.05 of these specifications. All seams shall be subject to the approval of the Engineer. Overlapped seams shall have a minimum overlap equal to the width of the trench and shall be anchored with securing pins as directed to insure the required overlap is maintained.

Where a filter repair is required, a piece of filter shall be placed over the damaged area and extend 3 feet {1 m} beyond the perimeter of the tear or damage.

When an outlet pipe passes through the filter, a separate piece of filter of sufficient size to be wrapped around the pipe and flared against the side of the filled drain filter shall be used.

Care shall be taken during the aggregate filler placement operation as well as the pipe installation, when required, to prevent damage to the filter.

The aggregate filler shall be placed and compacted by methods acceptable to the Engineer.

(c) Special Underdrain Outlets.

Outlets may be classified and paid for as types of "Special Underdrain Outlets" as follows:

Type A - Designated for connecting an aggregate filled or prefabricated drainage mat underdrain line to a roadway front slope and requires a slope paved headwall.

Type B - Designated for connecting an aggregate filled or prefabricated drainage mat underdrain line to a drainage structure (inlet, junction box, etc.).

Type C - Designated for providing an outfall from a drainage plane layer to a front slope and requires a slope paved headwall.

Other types may be added as shown on the plans.

The width of the outfall trench requiring non-perforated pipe shall be kept to a minimum. The pipe shall be installed with ordinary care and the backfill material placed in layers and compacted to the satisfaction of the Engineer.

For Type "A" and "C" outlets, the end of the outfall pipe shall be protected by a slope paved headwall. The end of the outfall pipe shall be modified as necessary to fit the headwall. Should the outlet end of the pipe or the headwall fall within the limits of ditch paving, that portion of the ditch paving within the headwall limits shall be removed to neat lines and the headwall made to blend with the ditch paving.

For a Type "B" outlet, the end of the outfall pipe shall be drained into a designated drainage structure. The wall of the structure to which the pipe is to connect shall be modified, adjusted, or replaced as necessary to provide a suitable connection. Any special fitting necessary to accomplish this connection will be considered incidental to the work.

For other types of special outlets, the construction requirements will be as noted by plan details.

Unless approved otherwise by the Engineer, all special underdrain outlets shall have a rodent protection screen made of galvanized hardware. The screens shall be as detailed on the plans; however, slight modifications to the configurations shown on the plans may be used if approved by the Engineer.

(d) Special Underdrain.

Drainage collection systems and outlets may be classified and paid for as "Special Underdrain Pipe". The details of these collection systems and outlets will be shown on the plans.

Special underdrain pipe is usually non-perforated pipe. Trench widths for the unperforated pipe shall be kept to a minimum. The pipe shall be installed with ordinary care, with bells, etc., laid upgrade and all joints sealed. Pipe connections shall be made using appropriate, approved fittings. Backfilling of the pipe trench shall be made by placing the backfill material in layers and compacting each layer as directed by the Engineer.

Connections to drainage structures shall be as detailed on the plans or approved by the Engineer.

605.04 Method of Measurement.

(a) Item 605-A.

Pavement median and edge drains will be measured in linear feet {meters} along the center of drainage line.

(b) Item 605-B.

1. Type A and B Outlets.

   Type A and B Special Underdrain Outlets will be measured in units of 20 feet {6 m} with measurements made along the center of the outfall pipe from the center of the pavement median or edge drain to the centroid of the outfall end. Adjustments will be made for payment purposes when the length of the outfall pipe exceeds 20 feet {6 m}.

2. Type C Outlets.

   Type C Special Underdrain Outlets will be measured individually as one complete unit.

3. Other Types of Outlets.

   The method of measurement of outlets other than the types of outlets noted above will be as noted by plan details.

(c) Item 605-C.

Special Underdrain Pipe will be measured in linear feet {meters} along the center of each line or lateral, center to center of fittings.

605.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item 605-A.

   Pavement median and edge drains will be paid for at the contract unit price which shall be full compensation for all materials, equipment, tools, and labor required to construct the drains. The unit price shall include excavation of the trench, disposal of excess material, installation of the geotextile filter, placement of the aggregate, installation of the perforated underdrain pipe, installation of the elbow at the outlet end of the drain line, any required outlet connections, and for all incidentals necessary to complete this item of work.

2. Item 605-B.

   A Special Underdrain Outlet, will be paid for at the contract unit price per each, which shall be full compensation for all materials, equipment, tools, and labor required for the construction of the outlet. The unit price shall include excavation of the trench, backfill and compaction of the trench, furnishing and installation of the pipe and fittings, furnishing and placing concrete for headwall or connection of outfall pipe to a structure, the disposal of excess material, and for all incidentals necessary to complete this item of work.

   Payment for the outfall pipe for Type A and B outlets shall be adjusted as follows:

Length of Outfall Pipe	% of Unit Price to be Paid
Over 6 feet {2 m} but less than 12 feet {4 m}	50 %
Over 12 feet {4 m} but less than 19 feet {6 m}	75 %
20 feet ± 1 foot {6 m ± 300 mm}	100 %
Over 21 feet {6 m} but less than 27 feet {8 m}	125 %
Over 27 feet {8 m} but less than 33 feet {10 m}	150 %
Over 33 feet {10 m} but less than 39 feet {12 m}	175 %
Over 39 feet {12 m} but less than 45 feet {14 m}	200 %

3. Item 605-C.

Special Underdrain Pipe will be paid for at the contract unit price, which shall be full compensation for all materials, equipment, tools, and labor required the installation of the pipe. The unit price shall include the furnishing of all pipe, fittings, and miscellaneous materials, excavation of the trench, installation of all materials, backfilling of the trench, disposal of excess materials, and for all incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

605-A Pavement _*_ Drain - per linear foot {meter}
605-B Special Underdrain Outlet, Type _____ - per each
605-C Special ____ inch {mm} Diameter Underdrain Pipe - per linear foot {meter}

* Median or Edge

SECTION 606
PIPE UNDERDRAIN

606.01 Description.

This Section shall cover the work of furnishing pipe underdrain of the type and sizes provided on the plans or in the proposal in accordance with the requirements of these specifications, and installing such pipe at the locations shown on the plans or designated and in substantial conformity with the established lines and grades. The work shall include the furnishing and construction of such joints and connections to other pipes, catch basins, endwalls, etc., as may be required to complete the work, as shown on the plans or directed, together with filter material and filter fabric as shown on Standard Drawing PU-606.

Designations for the various types of pipe shall be as follows:

Type	Kind	Abbreviations
1	Concrete Pipe	C.P.
2	Corrugated Steel	C.S.
3	Coated Corrugated Steel	C.C.S.
4	Vitrified Clay	V.C.
5	Corrugated Aluminum	C.A.
6	Coated Corrugated Aluminum	C.C.A.
7	Bituminous Fiber	B.F.
8	Poly (Vinyl Chloride)	P.V.C.
9	Acrylonitrile Butadiene Styrene	A.B.S.
10	Polyethylene	P.E.

Unless specific types of pipe are specified by the plans or proposal, the Contractor may, at his option, use any of the approved types provided herein. However, an installation once started shall have the same type pipe unless otherwise noted in the plans or directed in writing.

606.02 Materials.

Materials shall meet the requirements specified in Section 852, Underdrain Pipe, including filter material. The geotextile filter for aggregate filled underdrain shall meet the requirements shown on the plans and shall be a non-woven material meeting the requirements of AASHTO M 288 for Class 2 Subsurface Drainage Geotextile and Section 810 of these specifications. The geotextile shall be selected from List II-3 of the “Materials, Sources, and Devices With Special Acceptance Requirements” manual. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

All materials will be subject to further inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

606.03 Construction Requirements.

(a) Standard Pipe Installation.

Trenches shall be excavated to the dimensions and grade required by the plans or as directed. A minimum 3 inch {75 mm} bedding layer of filter material of the size shown on the plans shall be placed in the bottom of the trench for its full width and length and compacted as directed.

Exposure of geotextile to the elements between lay down and cover shall be a maximum of 10 days to minimize the potential for damage.

The geotextile filter shall be installed in such a manner that all splice joints are provided with a minimum overlap of 3 feet {1 meter}. Securing pins shall be installed to anchor the filter fabric if the geotextile material does not remain in place during the construction of the drains.

Where seams are required in the filter fabric in the longitudinal trench direction, they shall be joined by either sewing or overlapping as outlined in Article 608.05 of these specifications. All seams shall be subject to the approval of the Engineer. Overlapped seams shall have a minimum overlap equal to the width of the trench and shall be anchored with securing pins as directed to insure the required overlap is maintained.

Where a filter fabric repair is required, a piece of filter fabric shall be placed over the damaged area and extend 3 feet {1 meter} beyond the perimeter of the tear or damage.

When an outlet pipe passes through the filter fabric, a separate piece of filter fabric of sufficient size shall be wrapped around the pipe and flared against the side of the filled drain filter.

Care shall be taken during the aggregate filler placement operation as well as the pipe installation to prevent damage to the filter fabric.

The aggregate filler shall be placed and compacted by methods acceptable to the Engineer.

Subdrainage pipe of the type and size specified shall be embedded firmly in the bedding material.

Perforated pipe shall normally be placed with the perforations down, and the pipe sections shall be joined securely with the appropriate coupling fittings or bands.

Non-perforated pipe shall be laid with the bell end up-grade and with open joints, wrapped with acceptable material which will permit entry of water, yet prevent loss of filter material. Up-grade ends of all subdrainage pipe installations shall be closed with suitable plugs to prevent entry of soil materials.

After the pipe installation has been inspected and approved, filter material meeting the requirements of Article 852.10 shall be placed as specified on the plans to a minimum height of 12 inches {300 mm} above the top of the pipe. Care shall be taken not to displace the pipe or the covering at open joints. The remainder of the filter material shall then be placed and compacted to the required height. Any remaining portion of trench above the filter material shall be filled with granular or impervious material, as may be directed, and thoroughly compacted, consistent with the location of the trench within the work.

(b) Underdrain Outlets.

Trenches for underdrain outlets shall be excavated to the width and depth shown on the plans. Pipe shall be laid in the trench with all ends firmly joined by applicable methods and means. Perforated pipe shall be laid with holes up and covered with roofing paper, or non-perforated pipe meeting the same requirements of the perforated pipe may be used. After inspection and approval of the pipe installation the trench shall be backfilled with suitable soil in layers and compacted as provided for drainage pipe. Filter material will not be required for outlet trenches unless specified on the plans, or ordered by the Engineer.

606.04 Method of Measurement.

The accepted length of pipe underdrain, complete in place, of each specified size and type will be measured in linear feet {meters} along the center of each line or lateral, center to center of junctions and fittings.

606.05 Basis of Payment.

(a) Unit Price Coverage.

1. The accepted quantity of each kind and size of pipe underdrain will be paid for at the contract unit price for pipe underdrain, complete in place for a depth of 3 feet {1 meter} and less below existing ground line to bottom of trench which shall be payment in full for all excavation and its disposal, foundation preparation, backfilling, furnishing, hauling and placing of all materials including fittings, cutting for connections, joint material, bands, geotextile filter fabric, and aggregate filter material (or cover and bedding layer materials.)

2. Accepted quantity of pipe underdrain complete in place at depths greater than 3 feet {1 meter} below the ground line shall have an adjusted unit price, arrived at by increasing the contract price bid by the percentage indicated in the table below. The unit price coverage provided in Item 1 above shall govern for such adjusted unit price.

Depth Underdrain Installed Below Existing Ground Line	Extra Percentage Contract Unit Price Bid to be Increased
More than 3 feet {1 meter}, but less than 6 feet {2 meter}	20
6 feet {2 meter} and more, but less than 9 feet {3 meter}	50
9 feet {3 meter} and more, but less than 12 feet {4 meter}	75
12 feet {4 meter} or more	100

3. No separate payment will be made for excavation. The provisions of Article 214.04 are not applicable to this Section.

(b) Payment will be made under Item No.:

606-A ___ inch {mm} Underdrain Pipe, Type __* - per linear foot {meter}

* Note specific type or types of pipe if required. See Article 606.01 for approved types.

SECTION 607
PAVING GEOTEXTILES

607.01 Description.

(a) General.

This section shall cover the work of furnishing and placing a geotextile between pavement layers for the purpose of incorporating a waterproofing and stress relieving membrane within the pavement structure. This specification is applicable to geotextile membranes used for full coverage of the pavement, or as strips over transverse and longitudinal pavement joints. It is not intended to describe membrane systems specifically designed for pavement joints and localized (spot) repairs.

607.02 Materials.

(a) Paving Geotextiles.

The geotextiles used in this work shall be constructed of non-woven synthetic fibers meeting the requirements of AASHTO M 288 for Paving Fabric, Type II, and Section 810 of these specifications. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

(b) Asphalt Sealant.

The material used to impregnate and seal the geotextile, as well as bond it to both the base pavement and overlay, shall be a paving grade asphalt recommended by the geotextile manufacturer and approved by the Engineer.

Cutbacks and emulsions which contain solvents shall not be used. Uncut asphalt cements or cationic and anionic emulsions may be used provided these emulsions are used as outlined in Article 607.04 of these specifications.

(c) Aggregate.

If the ambient temperature is high enough to cause a bleed-through of the asphalt sealant, washed concrete sand may be spread over asphalt-saturated geotextiles to facilitate movement of equipment during construction or to prevent tearing or delamination of the geotextile. Excess quantities shall be removed from the geotextile prior to placing the surface course. A hot asphalt mix broadcast in front of construction vehicle tires may also be used.

607.03 Equipment.

(a) Asphalt Distributor.

The distributor shall be capable of spraying the asphalt sealant at the prescribed uniform application rate. No streaking, skipping, or dripping will be permitted. The distributor shall also be equipped with a hand spray having a single nozzle and positive shut-off valve.

(b) Geotextile Handling Equipment.

Mechanical or manual laydown equipment may be used provided the laydown is smooth and without wrinkles or creases.

(c) Miscellaneous Equipment.

Stiff bristle brooms or squeegees shall be provided to smooth the geotextile, scissors or blades for cutting same, and brushes for applying asphalt sealant at the geotextile overlaps.

When the ambient temperature is so low that the normal wicking of the asphalt sealant into the geotextile does not occur, a pneumatic roller may be used to ensure geotextile bond to the adjoining pavement layers, especially where thin lifts or chip seals are being placed.

607.04 Construction Requirements.

(a) Weather Limitations.

Neither the asphalt sealant nor geotextile shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. Air and pavement temperatures shall be sufficient to allow the asphalt sealant to hold the geotextile in place. For asphalt cements, the minimum air temperature shall be 50 °F {10 °C} and rising. When using asphalt emulsions, the minimum air temperature shall be 60 °F {15 °C} and rising.

(b) Surface Preparation.

The surface on which the geotextile is to be placed shall be free of dirt, water, vegetation, or other debris. Cracks exceeding 1/8 inch {3 mm} in width shall be filled with a rubberized joint sealer meeting the requirements of ASTM D 6690, for Type II sealant. Potholes shall be properly repaired as directed by the Engineer. The joint sealer shall be allowed to cure prior to geotextile placement.

(c) Application of Asphalt Sealant.

The asphalt sealant shall be spray applied uniformly to the prepared dry pavement surface at the rate of 0.20 to 0.30 gallons per square yard {0.9 to 1.36 L/m^2} or as recommended by the geotextile manufacturers and approved by the Engineer. The recommended application for asphalt cements is 0.20 gallons per square yard {0.9 L/m^2} with rough and ravelled surfaces requiring a higher application. When using emulsions, the application rate shall be increased to offset the water content of the emulsion.

Application of the sealant shall be by distributor spray bar, with hand spraying kept to a minimum. Temperature of the sealant shall be sufficiently high to permit a uniform spray pattern.

For asphalt cements, the minimum temperature shall be 290 °F {143 °C}. To avoid damage to the geotextile, however, distributor tank temperatures shall not exceed 325 °F {163 °C}. Spray patterns for asphalt emulsion can be improved by heating. Temperatures in the 130 to 150 °F {54 to 71 °C} range are recommended. A temperature of 160 °F {71 °C} shall not be exceeded since higher temperatures may break the emulsion.

The target width of asphalt sealant application shall be 6 inches {150 mm} wider than the geotextile width. The sealant shall not be applied any farther in advance of geotextile placement than the distance which the Contractor can maintain free of traffic.

Asphalt spills shall be cleaned from the road surface to avoid flushing and geotextile movement.

When asphalt emulsions are used, the emulsion shall be cured (essentially no water remaining) prior to placing the geotextile and final wearing surface.

(d) Geotextile Placement.

The geotextile shall be placed into the asphalt sealant with minimum wrinkling prior to the time the asphalt has cooled and lost tackiness. As directed by the Engineer, wrinkles or folds in excess of 1 inch {25 mm} shall be split and laid flat. Brooming and/or pneumatic rolling will be required to maximize geotextile contact with the pavement surface.

Overlap of geotextile joints shall be sufficient to ensure full closure of the joint, but should not exceed 6 inches {150 mm}. Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. A second application of asphalt sealant to geotextile overlaps will be required, if in the judgement of the Engineer, additional asphalt sealant is needed to ensure proper bonding of the double geotextile layer. Removal and replacement of damaged geotextile will be the responsibility of the Contractor.

Trafficking the geotextile will be permitted for emergency or construction equipment only.

(e) Asphalt Overlay.

Placement of the hot mix overlay shall closely follow geotextile laydown. The temperature of the mix shall not exceed 325 °C {163 °C}. In the event asphalt bleeds through the geotextile causing construction problems before the overlay is placed, the affected areas shall be blotted by spreading

sand or hot-mix. To avoid movement or damage to the geotextile membrane, turning of the paver and other vehicles shall be gradual and kept to a minimum.

(f) Seal Coats.

Prior to placing a seal coat (or thin overlay such as an open-graded friction course), the geotextile shall be lightly sanded at a spread rate of 1.5 to 2.0 pounds per square yard {0.8 to 1.1 kg/m^2} and pneumatically rolled so as to embed the geotextile tightly into the sealant.

607.05 Method of Measurement.

The paving geotextile will be measured by the square yard {square meter}.

Asphalt sealant for the paving geotextile will be measured by the gallon {liter}.

607.06 Basis of Payment.

(a) General.

The accepted quantities of paving geotextiles will be paid for at the contract unit price per square yard {square meter} in place. Accepted quantities of asphalt sealant for the paving geotextile will be paid for at the contract unit price per gallon {liter} complete in place.

(b) Payment will be made under Item No.:

607-D Paving Geotextile - per square yard {square meter}
607-E Asphalt Sealant - per gallon {liter}

SECTION 608
GEOTEXTILES IN SEPARATION APPLICATIONS

608.01 Description.

This section shall cover the furnishing and placing of geotextiles for use as a permeable separator to prevent mixing of dissimilar materials such as subgrades and surfaced and unsurfaced pavement structures, zones in embankments, foundations, and select fill materials. The geotextiles shall be designed to allow passage of water while retaining in situ soil without clogging.

When used as a soil stabilizer, a detailed design process shall be followed taking into consideration the separation function of the geotextile, along with its filtration and reinforcement functions.

608.02 Materials.

The geotextile shall meet the requirements of AASHTO M 288 for Separation Applications, Class 2, and Section 810 of these Specifications. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

608.03 Construction Requirements.

The installation site shall be prepared by clearing and grading the area as required. All sharp objects and large stones shall be removed and trees and shrubs shall be cut flush with the subgrade. The removal of top soil and vegetation is not necessary.

When appropriate, soft spots and unsuitable areas shall be identified during site preparation or subsequent proof rolling. These areas shall be excavated and backfilled with select material which is compacted to a depth such that the area provides equal stability as the adjacent area. Stabilization of these areas may be enhanced by use of a geotextile at the bottom of the excavation before backfill.

608.04 Installation.

The geotextile shall be unrolled as smoothly as possible on the prepared subgrade in the direction of the construction traffic. Adjacent geotextile rolls shall be overlapped in the direction of subbase placement using the following guide:

Required Overlaps		
Soil Strength (CBR)	Unsewn Overlap (inches {mm})	Sewn Overlap (inches {mm})
< 1	- -	9 {225}
1 - 2	38 {950}	8 {200}
2 - 3	30 {750}	3 {75}
> 3	24 {600}	- -

Unless shown otherwise on the plans, the required overlap shall be as shown for a CBR value of 1 - 2.

The geotextile may be held in place prior to subbase placement by pins, staples, or piles of fill or rock. Geotextiles may be folded or cut to conform to any curvature of the area. A fold or overlap shall be in the direction of construction and held in place as prescribed above.

608.05 Seams.

Both factory and field sewn or sealed seams shall conform to the strength requirements of Table 1 as outlined in AASHTO M 288 for Separation Applications. All seams shall be subject to the approval of the Engineer.

608.06 Subbase Placement.

The subbase shall be placed by end dumping onto the geotextile from the edge of the geotextile, or over previously placed subbase aggregate. On subgrades having a CBR of 1, the subbase aggregate shall be spread simultaneously with dumping to minimize the potential of a localized subgrade failure. Direct traffic on the geotextile, along with any sudden stops, starts, or turns on the subbase material by construction equipment, shall be avoided where possible. Using whatever means, the subbase material shall be spread from the back dumped pile. Except in the case of low volume roads (ADT < 200), a minimum thickness of 6 inches {150 mm} shall be maintained. In the case of low volume roads, this thickness shall be 4 inches {100 mm}. A smooth drum roller shall be used to achieve the specified density. Any ruts occurring during construction shall be filled with additional subbase material and compacted to the specified density. The use of vibratory compaction will not be allowed as it may cause damage to the geotextile.

608.07 Damage Repair.

Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. The damaged area, plus an additional 3 feet {1 m} around the area, shall be cleared of all fill material. This area shall be covered with a geotextile patch extending 3 feet {1 m} beyond the perimeter of the damage. The removed subbase material shall be replaced and compacted to the specified density.

608.08 Method of Measurement.

The geotextile will be measured by the square yard {square meter} from the payment lines shown on the plans, or from the payment lines established in writing by the Engineer. This excludes seam overlaps.

Excavation, backfill, bedding, and cover material are separate pay items.

608.09 Basis of Payment.

(a) General.

The accepted quantities of geotextiles will be paid for at the contract unit price per square yard {square meter} in place.

(b) Payment will be made under Item No.:

608-A Separation Geotextile - per square yard {square meter}

SECTION 609
AGGREGATE SLOPE PROTECTION

609.01 Description.

This Section shall cover the work of furnishing and constructing a slope protection layer of graded aggregate on slopes as shown on the plans or directed in accordance with these Specifications. This

Section shall also cover the work, if shown on the plans, of furnishing and installing a geotextile filter blanket on slopes which are to receive the aforementioned aggregate protection layer.

609.02 Materials.

Materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, and the following:

(a) Geotextile Filter.

1. General.

The geotextile shall meet the requirements of AASHTO M 288 for Permanent Erosion Control Geotextile, Class 2, and Section 810 of these specifications. In addition, the fabric shall have a minimum coefficient of friction of the wet fabric on wet aggregate of 0.4 as determined by the Department's Central Lab. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

2. Securing Pins.

Securing pins for anchoring the filter shall be 3/16 of an inch {5 mm} steel bars, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of not less than 1.5 inches {38 mm}. The length of the pin shall not be less than 18 inches {450 mm}.

(b) Aggregate.

The aggregate shall be crushed stone meeting the requirements given in Section 801. The aggregate gradation shall be:

AGGREGATE GRADATION FOR AGGREGATE SLOPE PROTECTION Percent Passing by Weight {Mass}		
Sieve Size	Minimum	Maximum
7" {175 mm}	100	-
6" {150 mm}	90	100
4" {100 mm}	20	55
3" {75 mm}	0	15
2" {50 mm}	0	5

609.03 Construction Requirements.

(a) Preparation of Surface.

The slope to be treated shall be prepared by removing vegetation, topsoil, and dressing the slope to reasonable line and grade. The surface shall then be compacted, if necessary, by the use of mechanical tampers to the satisfaction of the Engineer before placement of the geotextile filter and aggregate blanket. The dressing and preparation of the slope shall be considered incidental to the placement of the Aggregate Protection Blanket and no direct payment for such will be made.

Where grading has been completed under another contract and regrading is necessary to obtain the desired uniform slope, such regrading shall be considered incidental to the placement of the aggregate protection blanket and no direct payment for such will be made.

(b) Placement of Geotextile Filter.

The geotextile filter, if required, shall be placed in the manner and at the locations shown on the plans or as directed by the Engineer. Exposure of the geotextile to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential. At the time of installation, filter shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The filter shall be placed with the long dimension horizontal with the natural ground line, unless otherwise directed by the Engineer, and shall be laid smooth and free of tension, stress, folds, wrinkles or creases. The strips shall be placed to provide a minimum width of 3 feet {1 m} of overlap for each joint. Overlap joints and seams shall be measured as a single layer of cloth. Securing pins with washers shall be inserted through both strips of overlapped cloth at not greater than the following intervals along a line through the midpoint of the overlap.

Pin Spacing	Slope
2 feet {0.6 m}	Steeper than 1:3
3 feet {1.0 m}	1:3 to 1:4
5 feet {1.6 m}	Flatter than 1:4

The filter shall be turned down and buried approximately 12 inches {300 mm} at all exterior limits.

Additional pins, regardless of location, shall be installed as necessary to prevent any slippage of the geotextile filter. Each securing pin shall be pushed through the filter until the washer bears against the filter and secures it firmly to the foundation. The filter shall be protected at all times during construction from contamination by surface runoff and any filter so contaminated shall be removed and replaced with uncontaminated filter. Any damage to the filter during its installation or during placement of riprap shall be replaced by the Contractor. The work shall be scheduled so that 30 days does not expire between placement of the filter and the covering of the filter with the graded aggregate. Aggregate shall not be dropped on the filter from a height greater than 1 foot {300 mm}. Greater drop heights will be permitted if the Contractor provides a cushioning layer of sand on top of the filter before dumping of stone. The combination of drop height for stone and sand cushion layer thickness to be approved shall be demonstrated to not puncture or damage the filter. No measurement or separate payment shall be made for a sand cushion layer placed for the purpose of allowing an increased drop height of stones. Any damage to the geotextile filter during placement of aggregate shall be corrected prior to proceeding with the work.

(c) Placement of Aggregate.

The method of placement of the aggregate shall be at the option of the Contractor provided it produces uniform coverage and depth without damaging the geotextile filter, if present.

Any damage to the filter shall be cause for ordering the aggregate cleaned from the damaged area and the repair of the filter by an additional layer of filter covering the damaged area overlapping at least 3 feet {1 m} onto undamaged filter and securing the patch with adequate securing pins.

If uniformity of coverage is not obtained by the method of placement, such shall be corrected in a manner satisfactory to the Engineer.

No compaction of the aggregate blanket is required.

609.04 Method of Measurement.

Accepted aggregate slope protection and geotextile filter for aggregate slope protection, if applicable, will each be measured in square yards {square meters}, complete in place, computed from actual measurements taken along the top surface of the treated area to the nearest 0.1 square yard {0.1 m^2}.

609.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted Aggregate Slope Protection and geotextile filter for aggregate slope protection, measured as noted above, will each be paid for at the contract unit price bid per square yard {square meter}. Said unit price bid shall be full compensation for the item complete in place and includes the furnishing of all materials, the preparation of the slope (excavation, backfill, compacting slope, disposal of surplus material), placement of materials and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

609-A Aggregate Slope Protection - per square yard {square meter}
609-B Geotextile Filter for Aggregate Slope Protection - per square yard {square meter}

SECTION 610
RIPRAP

610.01 Description.

This Section shall cover the work of furnishing and constructing the several classes or types of riprap, each of which shall consist of a protective course of stone or other approved materials on embankment slopes, in channels and ditches, wave protection for causeways and shoreline roadway embankments, bridge piers and abutments, or other work as shown on the plans or directed, with or without a geotextile filter, all in accordance with these specifications and in conformity with the lines, and grades noted in the plan details.

610.02 Materials.

If a geotextile filter is required, it shall meet the requirements of AASHTO M 288 for Permanent Erosion Control Geotextile, Class 1, and Section 810 of these specifications. All other materials shall

conform to the requirements of Division 800, Materials. Specific reference is made to Section 814, Riprap Materials. The geotextile shall be selected from List II-3, of the Department's manual titled "Materials, Sources, and Devices With Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

In locations where maintaining the clear zone is a consideration, a traversable tied concrete block mat may be used in lieu of riprap. Tied concrete block mat shall be selected from the Department's Miscellaneous Approved Products List/LIST II-24 "TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS." All mats must be installed with the manufacturer's recommended underlayments/backings for site specific conditions. All mats and accompanying underlayments/backings shall have a minimum shear stress capacity of 10 pounds per square foot as tested per ASTM D6460. Prior to installation, the contractor shall submit documentation from the manufacturer, indicating the product meets the requirements for approval by the Engineer.

610.03 Construction Requirements.

(a) General.

All slopes to be treated with riprap shall be trimmed to the lines and grades indicated by the plans or directed; loose material shall be compacted by methods approved by the Engineer or removed.

Slopes which require a geotextile blanket under the riprap shall, in addition to the above, be prepared as noted in Subarticle (b) below.

Placement of any riprap on a filter blanket shall be by such means that will not damage or destroy the blanket. Any damage to the blanket shall be repaired without additional compensation.

Unless otherwise authorized or directed by the Engineer, riprap protection for bridge ends shall be placed immediately following the grading operations. The bridge Contractor shall protect any slope protection material in place during the bridge construction and shall be responsible for any damage due to negligence on the part of his operations.

If directed by the Engineer or shown by plan details, all outer edges and the top of riprap where the riprap terminates shall be formed so that the surface of the riprap will be embedded and even with the surface of the ground and/or slope.

All riprap construction shall begin at the bottom of the slope and progress upward.

(b) Filter Blanket.

1. General.

Unless otherwise specified by the plans or ordered in writing, the Contractor may select one of the filter blanket materials provided in Article 814.03 for construction of the filter blanket except that a geotextile blanket will not be allowed for soils with 85% by weight {mass} passing the #200 {75 µm} sieve.

If an aggregate blanket is used, the blanket shall be constructed using the designated material to a minimum thickness of 6 inches {150 mm}, unless otherwise shown by the plans, all in accordance with the provisions noted in this Subarticle and the plan details.

If a geotextile filter is used, it shall conform with Article 610.02 of this Section.

2. Foundation Preparation.

Areas on which filter blankets are to be placed shall be uniformly trimmed and dressed to conform to cross sections shown by the plans within an allowable tolerance of plus or minus 3 inches {75 mm} from the theoretical slope lines and grades.

3. Placement.

a. Aggregate Blankets (Gravel or Crushed Stone).

Filter blanket material shall be spread uniformly on the prepared base, in a satisfactory manner, to a thickness of not less than 1/2 of an inch {10 mm} from that specified and to neat lines as indicated on the plans. Placing or spreading of material by methods which will tend to segregate particle sizes within the filter layer will not be permitted. Any damage to the surfaces of the filter blanket foundation during the placing of the filter blanket shall be repaired before proceeding with the work. Compaction of the filter material will not be required, but shall be finished to present a reasonably even surface free from mounds, depressions, or windrows.

b. Geotextile Filter.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

The geotextile shall be placed and anchored on a smooth graded surface approved by the Engineer. The geotextile shall be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the filter. Anchoring of the terminal ends of the geotextile shall be accomplished through the use of key trenches or aprons at the crest and toe of the slope. In certain applications, 18 inch {450 mm} long anchoring pins, placed on 2 to 6 foot {1 to 2 m} centers, depending on the slope of the covered area, should be used to expedite construction.

Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the downstream sheet and/or upslope over downslope. In underwater applications, the geotextile and required thickness of backfill material shall be placed the same day. The backfill placement shall begin at the toe and proceed up the slope.

Riprap and heavy stone filling shall not be dropped onto the geotextile from the height of more than 1 foot {300 mm}. Slope protection and smaller sizes of stone filling shall not be dropped onto the geotextile from a height exceeding 3 feet {1 m}. Any geotextile damaged during placement shall be replaced as directed by the Engineer at the Contractor's expense.

The geotextile shall be joined by either sewing or overlapping. All seams shall be subject to the approval of the Engineer.

Overlapped seams shall have a minimum overlap of 12 inches {300 mm} except where placed underwater where the overlap shall be a minimum of 3 feet {1 m}.

A geotextile patch shall be placed over the damaged area and extend 3 feet {1 m} beyond the perimeter of the tear or damage.

(c) Stone Riprap.

1. General.

Unless otherwise shown by the plan details or directed, stone riprap shall not be placed on slopes steeper than the natural angle of repose of the riprap material.

Placement of stones may, unless otherwise noted in this Subarticle, be placed by methods and equipment approved by the Engineer suitable for the purpose of placing the riprap in accordance with the requirements for the class riprap involved without damaging any existing facility or construction feature.

2. Class 1.

Class 1 riprap is essentially designed for hand placement and use with minimal water currents. Stones shall be laid with close broken joints and resting on the embankment slope. The stones shall be of such shape and shall be so laid as to produce a single layer of stone of the thickness shown on the plans, measured perpendicular to the slope. The bottom course shall be laid in a trench excavated to such depth below the toe of the slope that all parts of the bottom course will be 3 feet {1 m} below the toe. Trenching will not be required where the toe of the slope is below water level. The back of the trench shall be on the same slope as the fill. The laying of the courses shall progress upward, the larger stones being placed in the lower courses. The individual pieces of stone in each horizontal course shall be laid so that they will break joints with the stones in the course below the tops sloped to drain away from embankment. Open joints shall be filled with spalls, or small stones in such manner that all stones are tightly wedged or keyed. The finished surface shall present a reasonably uniform appearance and shall not vary more than 6 inches {150 mm} from the average surface. The finished surface at the ends of the riprap shall be flush with the adjacent earth fill surface.

3. Class 2 and 3.

Class 2 and 3 riprap is designed for use in areas with minimal to medium water currents and wave action. The stones shall be placed in such a manner as to produce a reasonably well graded mass of rock with the minimum practical percentage of voids. The riprap shall be constructed to the lines, grades and thickness shown by the plans or directed within a tolerance of plus 15 inches {375 mm} or minus 3 inches {75 mm} from the designated finish surface of the riprap, except that either extreme of such tolerance shall be reached as a uniform rate over an area greater than 200 square feet {19 m^2}. Riprap shall be placed in its full course thickness in one operation and in such a manner as to avoid displacing the filter blanket material, where filter blanket is required. The larger stones shall be well distributed and the entire mass of stones in their final position shall conform to a reasonable uniform gradation. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap by dumping into chutes or by other methods likely to cause segregation of sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the source, by controlled dumping of successive loads during final placing, or by other methods of placement which will produce

the specified results. Rearranging of individual stones by mechanical equipment, or by hand, will be required to the extent necessary to obtain a reasonably well graded distribution of stone as specified above.

4. Class 4 and 5.

Class 4 and 5 riprap is designed for use in medium to high water currents and wave actions for the protection of bridge piers and abutments, and protection of channel slopes. Stones may be placed without strict gradation controls provided sufficient small sizes are included to choke the larger stones. Dumping of the stones will be allowed; however, mechanical equipment to dress the material to a reasonable uniform slope will be required. Stones deposited contrary to directions will be considered wasted and will not be paid for.

(d) Concrete Sacked Riprap.

Immediately following mixing, as noted in Article 814.02, the mixture shall be placed in the bags, tied (so that when laid in position they will flatten out and give a thickness of not less than 6 inches {150 mm} and placed flat on the area designated. Bags shall be rammed against each other to form closed joints, with tied ends of sacks all laid in the same direction. When required to be placed under water, special care shall be taken to see that bags are closely jointed to give the same tight joints as required on dry slopes. After the riprap is placed, it shall be sprinkled with water as directed and kept damp for not less than three days. No Concrete Sacked Riprap shall be mixed in freezing weather.

(e) Tied Concrete Block Mat.

Tied concrete block mat shall be placed according to the manufacturer's recommendations.

(f) Maintenance.

The Contractor shall maintain all riprap until the contract is accepted, and shall replace, without additional compensation, any damaged or lost riprap.

610.04 Method of Measurement.

Loose Riprap of the class designated by the plans or proposal will be measured in square yards {square meters}, computed from measurements taken parallel to the surface of the riprap or in tons {metric tons} as specified in Subarticle 109.0l(h), whichever is specified by the plans or proposal.

Concrete Sacked Riprap, Filter Blanket, and Tied Concrete Block Mat will be measured in square yards {square meters} computed from measurements taken parallel to the outer surface of the riprap or the filter blanket, whichever is applicable.

610.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for Loose Riprap, Concrete Sacked Riprap, Filter Blanket, and Tied Concrete Block Mat shall be full compensation for furnishing and hauling all materials, preparation of the placement area, placing materials and for all equipment, tools, labor and incidentals necessary to complete these items of work.

The preparation of the area for the placement of riprap and tied concrete block mat includes excavation, dressing the placement area and surrounding area, and the disposal of any excess excavated material. Payment for this preparation shall be included in the contract unit price for the riprap unless otherwise noted on the plans.

(b) Payment will be made under Item No.:

610-A Loose Riprap, Class ____ , ____ inches {mm} Thick - per square yard {square meter}
610-B Concrete Sacked Riprap - per square yard {square meter}
610-C Loose Riprap, Class ____ - per ton {metric ton}
610-D Filter Blanket, __* - per square yard {square meter}
610-E Tied Concrete Block Mat – per square yard {square meter}

* If a specific type of blanket is required, so designate (aggregate or geotextile).

SECTION 611
MORTAR FOR MASONRY

611.01 Description.

This Section shall cover the work of furnishing mortar made in accordance with these specifications, for the various classes and kinds of masonry when its use is required.

611.02 Materials.

Materials shall conform to the provisions of Division 800, Materials. Specific reference is made to the following:

Masonry Cement	Article 815.06
Sand	Article 802.03
Water	Article 807.01
Hydrated Lime	Section 805

611.03 Construction Requirements.

The mortar shall be composed of one part of cement and two parts of sand by volume, on basis of dry sand, and sufficient water to make a mortar of such consistency that it can be easily handled and spread with a trowel. If directed, hydrated lime, not to exceed 15 percent of cement by weight {mass}, shall be added, except that if masonry cement is used hydrated lime will not be required. Mortar shall be mixed only in quantities required for immediate use. Unless an approved mortar mixing machine is used, the sand and cement shall be mixed dry in a watertight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar which is not used within 45 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

611.04 Method of Measurement.

No measurement will be made for mortar for masonry.

611.05 Basis of Payment.

Payment for mortar for masonry shall be included in unit prices of pay items for various kinds of masonry, and no direct payment will be made for mortar.

SECTION 612
RUBBLE MASONRY

612.01 Description.

This Section shall cover the work of furnishing and constructing Rubble Masonry consisting of approved stones laid in mortar as a means of constructing structures or parts of structures in accordance with these specifications to the lines and dimensions shown on the plans or designated.

Rubble Masonry as herein specified shall include the Types commonly known as Coursed Rubble, Uncoursed Rubble, and Rustic Rubble.

612.02 Materials.

Materials shall conform to the provisions of Division 800, Materials. Specific reference is made to Type I and Type III, Masonry Stone, Subarticles 812.01(a) and (c), respectively.

Mortar shall meet the requirements of Section 611, Mortar for Masonry.

612.03 Construction Requirements.

(a) Shaping Stone.

1. Coursed and Uncoursed Masonry Stone.

   The stones shall be roughly squared on joints, beds and faces. All shaping or dressing of stone shall be done before the stone is laid and no dressing or hammering which will loosen the stone will be permitted after it is placed.

2. Rustic Masonry Stone.

   Only shaping required will be that to eliminate sharp points and projections.

(b) Weather Limitations.

Stone masonry shall not be constructed in freezing weather or when fresh mortar may be subject to freezing.

(c) Laying Details.

1. The masonry shall be laid to line and in courses roughly leveled. The bottom or foundation courses shall be composed of large, selected stones, and all courses shall be laid with bearing beds roughly parallel to the natural bed of the material. The stone and the layers shall decrease in thickness from bottom to top of wall. Stones of each color shall be uniformly distributed in exposed surfaces so that walls do not present a patched appearance. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls. Headers shall be evenly distributed and preferably arranged to interlock. Each stone shall be cleaned and saturated with water and shall be damp while being set, and the bed which is to receive it shall be cleaned and well moistened. All stones shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not more than 1 inch {25 mm}. The minimum thickness of mortar between stones shall be at least 1/2 inch {13 mm}. Whenever possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of 1.5 inches {38 mm} before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing. The vertical joints in each course of coursed masonry shall break joints with those in adjoining courses at least 6 inches {150 mm}. In case any stone is moved or the joint broken, the stone shall be removed, the mortar cleaned from bed and joints, and the stone reset in fresh mortar. Weepholes shall be constructed where indicated on the plans or designated. Immediately after laying and while the mortar is fresh, all face stones shall be cleaned of all mortar, and mortar stains and kept clean and free from mortar stains.

2. In Coursed and Uncoursed Rubble Masonry, headers shall hold in the heart of the wall the same or larger size than shown in the face. They shall extend not less than 12 inches {305 mm} into the core or backing and in walls 12 inches {610 mm} or less in thickness shall extend entirely through the wall. They shall occupy not less than 1/5 of the face of the wall.

3. In Rustic Rubble Masonry, stone shall be laid without regard to courses or patterns, have close joints and reasonably smooth faces and, if not coped, reasonably true lines on top of structure.

(d) Copings, Bridge Seats, and Backwalls.

Copings, bridge seats and backwalls shall be of the materials and size shown on the plans and when not otherwise specified shall be Minor Structure Concrete which shall conform to the requirements for Section 620. Concrete copings shall be made in sections extending the full width of the wall, not less than 8 inches {200 mm} in thickness and from 5 to 10 feet {1.5 to 3 m} long. The sections may be cast in place or precast and set in place in full mortar beds.

(e) Pointing.

Pointing shall not be done in freezing weather or when the stone contains frost. Joints not pointed at the time the stone is laid shall be wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept moist while pointing is being done and in hot dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least three (3) days after the mortar has set, or be cured as provided by Subarticle 450.03(m). After the pointing is completed and the mortar set, the wall shall be satisfactorily cleaned and left in a neat and workmanlike condition.

612.04 Measurement.

Accepted Rubble Masonry will be measured complete in place, and the volume actually constructed within the neat lines of the work shown on the plans or designated will be computed in cubic yards {cubic meters}.

612.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted volume of rubble masonry measured as above described will be paid for at the respective unit prices bid per cubic yard {cubic meter} for Coursed Rubble Masonry, Uncoursed Rubble Masonry, and Rustic Rubble Masonry, complete in place, which shall be payment in full for all material, equipment, tools, labor and incidentals necessary for the satisfactory completion of the work.

(b) Concrete.

Concrete used in conjunction with the Rubble Masonry will be paid for as provided under Minor Structure Concrete, Section 620.

(c) Payment will be made under Item No.:

612-A Type Rubble Masonry - per cubic yard {cubic meter}

SECTION 613
BRICK AND CONCRETE BLOCK MASONRY

613.01 Description.

This Section shall cover the work of constructing Brick or Concrete Block Masonry in accordance with these specifications at the locations and to the dimensions, lines, and grades as shown on the plans or established.

613.02 Materials.

All materials shall conform to the requirements of Division 800, Materials. Specific reference is made to the following:

Section 805 - Building Brick (Grade MW clay or shale brick unless otherwise specified on the plans or Concrete Brick and Concrete Block.)

Section 611 - Mortar for Masonry.

613.03 Construction Requirements.

(a) Brick Masonry.

The foundation shall be constructed firm and dry. All brick shall be damp at the time of laying. Bricks shall be laid in courses in full, close, uniform joints of mortar. Adjoining courses shall break joints by one-half length as nearly as practicable. The courses shall be level in all places, except where otherwise directed. All exposed surfaces shall be smooth and clean and the tie joint shall not exceed 1/2 inch {13 mm} in width. Broken or chipped bricks shall not be used in the faces of the masonry. The joints shall be cleaned and pointed before the mortar sets. The exposed surfaces of the bricks shall not be smeared with mortar forced out of the joints or that used in pointing, but shall be kept clean and free from mortar stains. For straight masonry walls, at least one course in seven shall be a header course. No masonry work shall be done in freezing weather.

(b) Concrete Block Masonry.

When so specified on the plans and/or in the proposal, masonry walls may be constructed of hollow concrete blocks instead of bricks. Applicable construction details shall be the same as for brick masonry.

(c) Manholes, Inlets, and Catch Basins.

Brick masonry for manholes, inlets, and catch basins shall conform to details shown on the plans. Construction details shall be as specified in Subarticle 613.03(a). Where shown on the plans, the faces of these and similar structures shall be given a plaster coat. Mortar for this coat shall be of the same mix as used in laying the brick and the coat shall be not less than 1/4 of an inch {6 mm} in thickness. Before applying the plaster coat, the brick shall be thoroughly wetted and the surface allowed to dry sufficiently to insure proper bond of the plaster coat.

Full mortar beds shall be provided for setting castings required by the plans. Castings shall be set carefully to the specified elevations.

613.04 Method of Measurement.

The quantity of Brick or Concrete Block Masonry will be measured in cubic yards {cubic meters} of completed and accepted masonry, except that when the proposal specifies payment by the unit for manholes, inlets, and the like, measurement will be by the completed and accepted units.

613.05 Basis of Payment.

(a) Unit Price Coverage.

The number of cubic yards {cubic meters} of Brick Masonry or Concrete Block Masonry, measured as provided above, will be paid for at the respective contract unit prices for these items, which shall

be payment in full for excavating except as specified in Section 214, laying, backfilling and for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Manholes, inlets, catch basins, and the like will be paid for as specified in Section 620.

(b) Payment will be made under Item No.:

613-A Brick Masonry - per cubic yard {cubic meter}
613-B Concrete Block Masonry - per cubic yard {cubic meter}

SECTION 614
SLOPE PAVING

614.01 Description.

This Section shall cover the work of paving with concrete any fill or cut slopes as shown on the plans or designated. The slope paving shall be laid to line, grade, and dimensions shown on the plans or directed.

Slope paving shall include, but not be limited to, paving of slopes at bridge ends, under grade separation structures, concrete slope drains, paving of side ditches, median ditches, special ditches, and other designated areas for control of erosion. Slope paving shall include wire mesh or other type of reinforcement when and as shown on the plans.

614.02 Materials.

The concrete shall meet the requirements of Section 501. Consideration will be given to the use of local or manufactured fine aggregate meeting the requirements of Section 826; if approved, the aggregate proportions shall be varied as directed.

Steel reinforcement shall meet the appropriate requirements of Section 835.

Joint filler and sealers shall meet the appropriate requirements of Section 832.

614.03 Construction Requirements.

The slope to be paved shall be uniformly dressed and compacted with mechanical tampers to the satisfaction of the Engineer before placing the concrete. Where grading has been completed under another contract and regrading is necessary to obtain correct grades for the slope paving, such regrading shall be considered incidental to the placement of the slope paving and no measurement or direct payment for such will be made. The concrete shall be mixed, placed, and cured in accordance with the requirements of Section 501, which is applicable to this work. Weep holes approximately 3 inches {75 mm} in diameter shall be placed in alternate runs of the pavement where deemed necessary by the Engineer. After placing, the concrete shall be finished smooth and unless otherwise directed, when partially set, shall be cut with a finishing tool as shown on the plans. Where reinforced concrete slope paving is specified on the plans, reinforcement shall be placed in accordance with details shown on the plans, and in conformity with requirements of Section 502.

Unless otherwise shown on the plan details, joints for slope paved areas shall be in accordance with the following:

(a) Contraction Joints.

This type joint is essentially provided to control cracking and may be formed by tooling, sawing or other approved methods for not less than 1/5, nor more then 1/4 the depth of the concrete. Except for sawed joints, all joints shall be finished with a 1/4 inch {6 mm} edging tool.

For flumes and ditch paving not adjacent to other paving, the transverse contraction joint spacing shall be as approved by the Engineer, but generally not in excess of 30 feet {9 m}. Longitudinal contraction joints may be ordered by the Engineer for paving widths in excess of 30 feet {9 m}, but are not to be placed where joint cracking will cause excessive seepage into subgrade.

For medians, islands, and ditches paved adjacent to curbs, gutters, or other paving, transverse contraction joint spacing shall be located wherever possible so as to line up with existing joints. Longitudinal contraction joints may be ordered for paving widths in excess of 20 feet {6 m} to control pavement cracking.

(b) Construction Joints.

The use and spacing of construction joints shall be as approved by the Engineer, consistent with the planned contraction and expansion joints for the paved area and the Contractor's paving plan. The

edges of all construction joints shall be finished with a 1/4 inch {6 mm} edging tool unless otherwise ordered by the Engineer.

(c) Expansion Joints.

Unless otherwise shown by plan details or directed by the Engineer, expansion joints 3/8 of an inch {9 mm} wide shall be placed as follows:

- Where the slope paving joins drainage structures and other rigid structure supports.
- To line up with expansion joints of adjoining pavement curbs, gutters, etc., but in no instance more than 80 feet {24 m} between joints.
- Where continuous runs of slope paving are 80 feet {24 m} or longer, transverse expansion joints shall be provided; one joint for each additional 80 feet {24 m}, or fraction thereof, of length.
- Where slope paving is confined longitudinally by other concrete units and the width of the slope paving is in excess of 15 feet {5 m}, one longitudinal expansion joint will be required for each additional 15 feet {5 m}, or fraction thereof, of width.
- Paved islands of 200 square feet {19 m^2} or less may be poured as a monolith if approved by the Engineer.
- Expansion joints shall be formed using a filler and sealer specified in Articles 832.01 and 832.02.
- Unless shown otherwise by plan details, the joint filler shall be from the bottom of the slope paving to 1 inch {25 mm} from the top; the sealer shall be 3/4 of an inch {19 mm} thick and shall be recessed 1/4 of an inch {6 mm} from the top.

614.04 Method of Measurement.

Slope paving will be measured in cubic yards {cubic meters} of paving, complete in place. Regrading in excess of 12 inches {300 mm} depth as described in Article 614.03 will be measured and paid for as Structure Excavation, Section 214.

614.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted quantity as determined above shall be paid for at the contract unit price for slope paving, which shall be payment in full for all excavation, backfilling, compacting slopes to be paved, disposal of surplus material, furnishing all materials, mixing, curing, hauling, and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

(b) Payment will be made under Item No.:

614-A Slope Paving - per cubic yard {cubic meter}
614-B Reinforced Slope Paving - per cubic yard {cubic meter}

SECTION 615
GROUTED RUBBLE SLOPE DRAIN

615.01 Description.

This Section shall cover the work of constructing gutter slope drain of grouted rubble masonry in accordance with the plans and these specifications and to the established lines, grades, and cross section shown on the plans and designated.

615.02 Materials.

(a) General.

The materials shall conform to the requirements of Division 800, Materials. Specific reference is made to Subarticle 812.0l(b), Type II, Masonry Stone.

(b) Grout.

Grout shall meet the requirements of Section 611, Mortar for Masonry, except that it shall be of wetter consistency to flow as indicated in Subarticle 615.03(c).

(c) Base Course Material.

Material shall be taken from sources shown on the plans or other approved sources of equal quality.

615.03 Construction Requirements.

(a) Foundation.

The foundation shall be formed at a depth of not less than 8 inches {200 mm} below and parallel to the finished surface of the slope drain. All soft or other unsuitable material shall be removed, and the foundation shall be compacted and finished to a smooth, firm surface.

(b) Bedding Stone.

The approved foundation material shall be prepared to form a bed as provided by the plans. The slope drain stone shall be bedded in the foundation perpendicular to the finished surface, flat face up, with the longest dimension parallel to the slope drain. The stone shall be fitted and laid in close contact and shall break joints satisfactorily.

Each stone shall be tamped into place until the stones are firm and the surface conforms to the finished grade and cross section.

(c) Finishing.

While the slope drain stones are being tamped, the spaces between stones shall be filled and rammed with backfill material selected from unclassified excavation, to within 3 inches {75 mm} of the top and any irregularities in the slope drain corrected. The cement grout shall be poured and broomed into the spaces between and over the stones. This operation shall be continued until the grout remains flush with the tops of the stones. The slope drain shall be protected by wet burlap until the grout hardens, then kept moist for at least three days after grouting. No grout shall be poured in freezing weather.

615.04 Method of Measurement.

Accepted Grouted Rubble Masonry Slope Drain will be measured in square yards {square meters} complete in place, along the finished surface both longitudinally and transversely, and computed to the nearest 0.1 square yard {0.1 m^2}.

615.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted Grouted Rubble Slope Drain will be paid for at the contract unit price per square yard {square meter}, complete in place, which shall be payment in full for excavating and preparing the foundation bed, placing and grouting the stone and for furnishing all materials, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

615-A Grouted Rubble Slope Drain - per square yard {square meter}

SECTION 616
SOIL CEMENT FLUMES

616.01 Description.

This Section shall cover the work of constructing soil cement flumes at locations designated in accordance with details shown on the plans.

616.02 Materials.

All materials shall conform to the requirements of Division 800, Materials. Specific reference is made to the following:

Cement, Section 815.
Water, Subarticle 807.01(b).
Local Sand, Sand-Gravel, and Stone Screening
for Miscellaneous Construction, Use Section 826.
Preformed Joint Filler, Article 832.01.

Test specimens will not be required for soil cement flume.

616.03 Construction Requirements.

(a) Subgrade.

Subgrade shall be finished and compacted to the section as shown on the plans or as designated. Side forms and transverse forms of the size and shape necessary to secure the desired section shall be placed prior to the placing of the mix and at such intervals which will insure a true finished grade and section by screeding with a straightedge.

(b) Mix.

The mix shall be one part Portland cement and six parts, by loose moist volume, local sand or sand-gravel and shall be mixed in an approved concrete mixer or by approved hand methods to a consistency dry enough to stand on the slopes without subsequently settling and sloughing, and tamped, rough graded, and finished by means of a hand float. After screeding, the surface shall be finished by hand float methods.

(c) Curing.

As soon as the soil cement has hardened sufficiently to prevent marring of the surface, and not later than the morning following its placement, it shall be cured for a period of 72 hours using one of the methods provided in Article 450.03.

(d) Joints.

Transverse expansion joints shall be constructed at maximum intervals of 40 feet {12 m}. They shall be filled with either preformed joint filler or acceptable yard lumber board of 1 inch {25 mm} (nominal size) pine, S4S. The finished surface shall be scored transversely with a grooving tool to a depth of at least 1/2 inch {13 mm} so as to form a weakened plane joint at intervals of 6 feet {2 m}.

(e) Toe Walls.

Toe walls shall be constructed across the ends of each flume as follows:

On upper end a toe wall of 6 inches {150 mm} in thickness and 12 inches {300 mm} in minimum depth below subgrade of the flume; on the lower end a toe wall 6 inches {150 mm} in thickness and 12 inches {600 mm} in minimum depth below subgrade.

(f) Solid Sod Strip.

A strip of solid sod shall be placed along each edge of the flume.

616.04 Method of Measurement.

Accepted soil cement flume will be measured in square yards {square meters}, complete in place, along the finished top surface both longitudinally and transversely and computed to the nearest 0.1 square yard {0.1 m^2}.

616.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted Soil Cement Flume, measured as provided above, will be paid for at the contract unit price per square yard {square meter}, complete in place, which shall be payment in full for excavating and preparing the subgrade and foundation bed, furnishing and erecting forms, furnishing all materials, mixing and placing the mix, curing, backfilling, and for all other materials, tools, labor, and incidentals necessary to complete the work. Aggregate, available from the right-of-way, may be obtained by the Contractor without any charge for royalty and such material will not be included in excavation items. No direct payment will be made for toe walls. The solid sod strip will be paid for under Item 654, Solid Sod.

(b) Payment will be made under Item No.:

616-A Soil Cement Flume - per square yard {square meter}

SECTION 617
BITUMINOUS TREATED GLASS FIBER FLUMES

617.01 Description.

This Section shall cover the work of furnishing and placing a layer of bituminous treated glass fibers on planted ditch slopes and other areas as shown on the plans or directed.

617.02 Materials.

(a) Glass Fibers.

Glass fiber material used for mulching shall consist of continuous fibers drawn from molton glass, coated with a chrome-complex sizing compound; collected into strands and lightly bound together without the use of clay, starch or like deleterious substances. The glass fibers shall be formed or wound into a cylindrical package in such a manner that the glass fibers can be continuously fed through an ejector driven by compressed air and expanded into a mat of glass fibers on the soil surface. The material shall contain no petroleum solvents or other agents known to be toxic to plant or animal life.

The glass fibers shall conform to the following specific requirements:

Property	Limits	Test Method
fiber diameter	0.00035 to 0.00053 inches {8.89 to 13.46 µm}	ASTM D 578
yards/pound {m/kg} of fibers	340 - 600	ASTM D 578
organic content	1.65% Max.	ASTM D 578
pkg. weight {mass}	30 - 45 pounds {14 - 20 kg}	ASTM D 578

(b) Bituminous Asphalt.

Asphalt shall be one of the emulsified type permitted by Subitem 860.03(b)7.b and complying with the requirements noted therein.

617.03 Construction Requirements.

(a) General.

The surface to be treated shall have been installed and prepared by one of the methods provided in Section 652, 653, or 654, unless otherwise directed by the Engineer.

Application of the Bituminous Treated Glass Fibers shall be accomplished within 24 hours after completion of planting operations.

(b) Application of the Glass Fibers.

The glass fibers shall be dispersed by equipment specifically designed for the purpose of using compressed air as the moving force. The glass fibers shall be spread over the area to be treated at a rate of approximately 0.4 to .05 pounds per square yard {217 to 271 g/m^2}.

Where water is expected to enter the flume, the fiber blanket shall be anchored into the natural ground a minimum of 9 inches {225 mm}.

(c) Bituminous Treatment of Glass Fibers.

After application of the glass fibers, the area shall be treated with emulsified asphalt (undiluted) at the approximate rate of 0.25 to 0.35 gallons per square yard {1.13 to 1.58 L/m^2}.

After application of the asphalt and the emulsion has broken and become tacky, a light application of sand or pulverized soil shall be applied to the treated area, if so directed by the Engineer, so as to prevent adherence of objects which may come in contact with the asphalt. Care shall be taken not to apply sand or soil in an amount detrimental to the newly planted area.

(d) Maintenance.

The Contractor shall maintain and repair the treated area to the satisfaction of the Engineer until final acceptance.

617.04 Method of Measurement.

Accepted Bituminous Treated Glass Fiber Flumes will be measured in square yards {square meters} computed from surface measurements to the nearest 0.1 square yard {0.1 m^2}.

Erosion control treatment required under the Bituminous Treated Glass Fiber Flumes will be measured and paid for under the appropriate item of erosion control ordered used.

617.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted Bituminous Treated Glass Fiber Flumes, measured as noted above, will be paid for at the contract unit price bid per square yard {square meter} which shall be full compensation for the furnishing of all materials, the placing of materials and includes furnishing of all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

617-A Bituminous Treated Glass Fiber Flumes - per square yard {square meter}

SECTION 618
CONCRETE SIDEWALKS AND DRIVEWAYS

618.01 Description.

This Section shall cover the work of constructing a portland cement concrete sidewalk or driveway. Sidewalks and driveways shall be constructed to the lines, grades, and typical cross-sections shown on the plans with or without reinforcement and in one course on a prepared subgrade. "Subgrade" in this Section shall mean the prepared foundation on which the sidewalk or driveway is constructed. Detectable warning surfaces shall be installed as shown on the plans..

618.02 Materials.

All materials furnished for use shall comply with the appropriate requirements of Division 800, Materials, and the following:

- Concrete shall meet the requirements for a Class A concrete as provided in Section 501.
- Reinforcing steel shall meet the requirements of Section 502 and plan details.
- Detectable Warning Surfaces shall be selected from the Department's List II-25, Detectable Warning Devices in the MSDSAR.

618.03 Construction Requirements.

(a) Equipment.

The equipment used for mixing concrete shall conform to the requirements of Section 501.

The Contractor may use forms or, if requested in writing and approved by the Department, an approved automatic extrusion type paving machine.

Forms shall be of wood, or metal, and shall be sufficiently staked to hold them true to line and grade while concrete is being deposited against them. If of wood, they shall be 2 inch {50 mm} or 3 inch {75 mm} (nominal size) stock lumber surfaces on all sides. If of metal, they shall be of approved section having a base width of at least 4 inches {100 mm} and shall have a flat surface on top. The depth of the forms shall equal the depth of the sidewalk or driveway. Adequate means shall be provided for securely fastening the ends of forms together.

Any automatic extrusion machine considered must be demonstrated to produce a consolidated concrete section conforming to the dimensions, cross-section, line, and grades shown on the plans or directed within the requirements noted herein in this Section.

(b) Subgrade.

All soft or other unsuitable material in the subgrade shall be removed and replaced with suitable material. All fills and filling material shall be placed and compacted by rolling with an approved roller or hand tamped with approved tamping devices in layers not exceeding 6 inches {150 mm} in thickness. Any existing areas that have been previously compacted by traffic to a greater degree than the remainder of the subgrade, shall be loosened and the whole subgrade uniformly compacted as directed.

(c) Foundation Backfill.

Where provided by the plans and/or proposal, foundation backfill shall be placed and constructed as provided in Section 214. No direct payment will be made for foundation backfill except when Item 214-B is provided in the proposal and such is ordered placed by the Engineer.

(d) Setting Forms.

Forms shall be set to true line and grade and rigidly held in place by stakes or braces. Ends of adjoining form sections shall be flush. Forms and division plates shall be cleaned and oiled before placing concrete against them.

(e) Handling, Measuring, Proportioning, and Mixing Materials.

The method of handling, measuring, proportioning, and mixing concrete materials shall conform to Section 501, Structure Concrete. Where metal reinforcement is shown on the plans and/or provided in the proposal, it shall be placed in accordance with Section 502.

(f) Placing Concrete.

A template resting upon the side forms and having its lower edge at the exact elevation of the subgrade shall be drawn along the forms and the subgrade shaped true before any concrete is deposited. The subgrade shall be moist and shall be free of debris and all foreign material when concrete is deposited upon it. The freshly mixed concrete shall be placed promptly on the prepared subgrade to

the depth required to complete the sidewalk or driveway in one course. It shall then be vibrated and/or tamped and struck off with an approved straightedge resting upon the side forms and drawn forward with a sawing motion. The concrete shall then be floated with a wooden float until the surface is true. Concrete laid during cold weather shall conform to the requirements given in Section 501.

(g) Curb and Gutter Transitions.

The Contractor shall make any necessary transitions in the curb and gutter to match the surface of the curb ramp. These transitions shall be made according to the plan details or as directed by the Engineer.

(h) Joints.

Unless otherwise shown by plan details, the surface of sidewalks and driveways shall be marked in squares or rectangles not exceeding 36 square feet {3.5 m^2} in area by using an approved marking tool. The marking tool shall provide a groove approximately 1 inch {25 mm} in depth and with rounded edges.

Unless otherwise directed by the Engineer, expansion joints 3/8 of an inch {9 mm} (min.) wide shall be placed as follows:

At all curb returns and where the walks or drives join other rigid units.

To line up with expansion joints of adjacent curbs, drives, etc., but in no instance more than 80 feet {24 m} between joints.

Where continuous runs of walks or drives are 80 feet {24 m} or longer, transverse expansion joints shall be provided; one joint for each additional 80 feet {24 m} or fraction thereof, of length.

Where walks or drives are confined longitudinally by other concrete units and the width of the walk or drive is in excess of 15 feet {5 m}, one longitudinal expansion joint will be required for each additional 15 feet {5 m}, or fraction thereof, of width.

Expansion joints shall be formed using a filler and sealer specified in Articles 832.01 and 832.02.

Unless shown otherwise by plan details, the joint filler shall be from the bottom of the walks or drives to 1 inch {25 mm} from the top; the sealer shall be 3/4 of an inch {19 mm} thick and shall be recessed 1/4 of an inch {6 mm} from the top.

(i) Curing and Protecting.

Immediately after the finishing operations have been completed, the entire surface of the newly laid concrete shall be protected against rapid drying out and cured as provided in Subarticle 450.03(m), unless the Contractor elects to use Type III portland cement, in which case the total curing time will be reduced. No vehicles shall be permitted on the new concrete for seven days and pedestrians shall not be permitted thereon for at least 72 hours unless the Contractor elects to use Type III portland cement, in which case the time limit will be reduced to 24 hours for walks and four days for driveways.

(j) Backfilling.

After the concrete has set sufficiently, the side forms shall be removed and the spaces on both sides shall be backfilled with suitable material. This backfill shall be compacted to a level 1 inch {25 mm} below the walk or driveway and left in a neat and workmanlike condition.

(k) Detectable Warning Surface

Detectable warning surfaces shall be installed according to the details shown in the plans and the manufacturer's recommendations.

618.04 Method of Measurement.

The quantity of accepted sidewalks or driveways will be measured, complete in place, and the area computed in square yards {square meters}. Measurement for separate payment for foundation backfill will only be made when Item 214-B is provided in the proposal and such is ordered by the Engineer.

Detectable warning surfaces shall be measured per square foot {square meter}, complete in place.

Curb ramps shall be measured in square yards {square meters} and shall include the areas within the pay limits shown on the plans.

618.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted quantity of sidewalk or driveway will be paid for at the contract unit price for Concrete Sidewalks or Concrete Driveways, complete in place, which shall be payment in full for furnishing all materials (including joints), for the hauling, preparation, and placing of all materials, for the preparation of the subgrade, excavation, backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the work.

Payment for detectable warning surfaces shall include preparation of the underlying surface, labor, equipment, tools, and incidentals necessary to complete the work.

Payment for curb ramps shall include all excavation, subgrade preparation, grading, making transitions in the curb and gutter, construction of joints, and for all labor, equipment, tools, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

618—A Concrete Sidewalk, ____ inch(es) {mm} Thick - per square yard {square meter}
618—B Concrete Driveway, ____ inch(es) {mm} Thick - per square yard {square meter}
618—C Detectable Warning Surface - per square foot {square meter}
618—D Curb Ramp – per square yard {square meter}

SECTION 619
PIPE CULVERT END TREATMENTS

619.01 Description.

This Section shall cover the work of constructing a pipe culvert end treatment in accordance with these specifications and the plan details, at the locations shown on the plans or directed.

Unless specified otherwise on the plans or in the proposal, the Contractor may, for the required end treatment, either furnish and install a prefabricated pipe culvert concrete end section or construct a slope paved headwall, all in accordance with plan details and these specifications.

Class 1 shall designate those end treatments which do not require a grate. Class 2 shall designate those end treatments which do require a grate.

619.02 Materials.

All materials furnished for use shall conform to the appropriate requirements of Section 614; Division 800, Materials; the plan details; and the following:

Concrete end sections shall comply with the requirement shown by plan details and Section 850 for Class 3 pipe except that the three-edge-bearing test will not be required.

Concrete end sections with metal sleeves shall comply with the provisions noted above. The metal sleeve shall comply with the appropriate provisions of Articles 850.02 and 850.03. Metal sleeves used in conjunction with coated and/ or paved invert pipe shall be coated using the same coating, with the exception of paved invert, used in the pipe culvert to which the sleeves are attached. In lieu of the bituminous coating, the Contractor may substitute a polymeric coating meeting the requirements specified in Item 850.02(c)2.

Safety grates, when required, shall be fabricated in accordance with plan details.

619.03 Construction Requirements.

(a) Excavation and Backfill.

All excavation involved shall be in accordance with the provisions of the Sections for the type pipe involved and Section 214. Backfilling shall be as specified under Sections 210, 214 and the applicable Pipe Culvert Section.

(b) Installation of End Treatments.

When prefabricated end sections are used, they shall be installed and securely affixed to the pipe line as shown on the plans or directed, all in conformity with the established lines and grades for the structure.

When slope paved headwalls are used, they shall be constructed as shown on the plans.

619.04 Method of Measurement.

The number of end treatments measured for payment will be the actual number of end treatments of the designated size and class, complete in place, on each designated pipe culvert.

619.05 Basis of Payment.

(a) Unit Price Coverage.

The ordered and accepted pipe culvert end treatment of the designated class for each size and appropriate type of pipe to which the end treatment is attached, measured as noted above, will be

paid for at the contract unit price bid for the end treatment. Such price shall be full compensation for the furnishing of all materials and the installation and construction thereof, except for the items of Structure Excavation and Foundation Backfill, necessary for the complete construction of the end treatment, and for all labor, tools, equipment, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

619-A ___ inch {mm} __* Pipe End Treatment, Class ____ - per each
619-B ___ inch {mm} Span, ___ inch {mm} Rise ___*___ Pipe End Treatment, Class ____ - per each

* Specify Roadway or Side Drain.

SECTION 620
MINOR STRUCTURE CONCRETE

620.01 Description.

This Section shall cover the work of constructing minor concrete structures such as pipe culvert headwalls, inlets and junction boxes, concrete steps, coping walls, and other miscellaneous items. All of which shall be constructed in accordance with the details shown on the plans and these specifications to the lines and grades established by the plans or directed.

620.02 Materials.

All materials furnished for use shall conform to the requirements of Division 800, Materials, and the following:

Section 501	Structure Concrete
Section 502	Reinforcing Steel

620.03 Construction Requirements.

(a) General.

The concrete mix used for minor structure work shall be Class A concrete unless otherwise provided by plan details, all in accordance with the appropriate provisions of Section 501.

(b) Excavation and Backfill.

Excavation and backfill shall be in accordance with the provisions of Sections 210 and 214.

(c) Forming and Placing of Concrete.

Construction, forming, placing, etc. of the structures shall be in accordance with the requirements given in Section 501.

(d) Finishing and Curing.

Attention is directed to the requirement given in Section 501 that all surfaces receive a Class 1 surface finish and that all exposed surfaces receive a Class 2 surface finish, unless otherwise specified in the proposal or by plan requirements.

In order to permit proper surface finishing, forms may be removed as soon as the concrete has set sufficiently that form removal will not damage the green concrete, but in no event less than 12 hours after completion of the placing. Immediately after the pouring operations, surfaces not covered by forms shall be covered with one of the curing materials specified in Section 830. Immediately after the removal of the forms, the surface finishing operations noted in Section 501 shall commence, and the curing operations continued for at least 72 hours after the finishing operation, using one of the curing materials specified in Section 830 and the related curing method required with the material used. Failure to apply the initial surface finish or perform the curing operation as noted herein shall be just cause for rejection of the concrete. Removal and replacement of rejected concrete shall be at no additional cost to the Department.

(e) Concrete Surface Tolerances.

The finished concrete shall be within reasonably close conformity to the lines, grades, and dimensions shown on the plans or directed, and free from objectionable cavities or projections.

620.04 Method of Measurement.

The volume of accepted concrete within the neat lines of the structure as shown on the plans or revised at the written direction of the Engineer will be computed in cubic yards {cubic meters}. The method of average end areas will not be used where results obtained differ from those obtained by more accurate mathematical computation.

No deduction will be made for the volume of concrete displaced by steel reinforcement, weep holes, conduits, anchor bolts, or for chamfers of less than 3 inch {75 mm} leg measurements.

Attention is directed to Section 502 for Reinforcing Steel, and Sections 210 and 214 for Excavation and Foundation Backfill.

620.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted Minor Structure Concrete, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the concrete complete in place including furnishing all materials (except reinforcing steel), form work, finishing and for all equipment, tools, labor, and incidentals necessary to complete the item in accordance with plan details and these specifications. In case of modification to an existing structure, the breaking away of the concrete to the approximate lines shown on the plans and the disposal of the broken concrete and the preparation of the retained steel reinforcement for splicing as required shall be considered incidental to the work and the cost thereof absorbed in the unit price bid.

(b) Payment will be made under Item No.:

620-A Minor Structure Concrete - per cubic yard {cubic meter}

SECTION 621
INLETS, JUNCTION BOXES, MANHOLES, AND MISCELLANEOUS DRAINAGE STRUCTURES

621.01 Description.

This Section shall cover the work of furnishing and installing miscellaneous drainage structures including necessary metal frames, grates, covers, etc. in accordance with the plan details and these specifications at the locations and to the grades shown on the plans or directed by the Engineer.

The various units will be further designated by type to distinguish shape, size, etc. by plan details. Certain units or portions of units may be constructed of cast-in-place concrete, precast concrete, and/or masonry as specified by plan details.

This Section shall also include the furnishing and installing of grates on new or existing structures when the Item of 621-G is provided on the plans, otherwise, inlet grates are classified as an integral part of the inlet or catch basin.

This Section shall also include the furnishing and installing of stilling basins when the Item of 621-I is provided on the plans.

621.02 Materials.

(a) Concrete, Reinforcing Steel and Masonry.

Concrete and reinforcing steel for cast-in-place units and for precast units or parts of units not covered by other requirements shall conform to the requirements of Sections 620 and 502.

Precast concrete units or portions of units shall conform to the appropriate requirements of ASTM C 478, and Section 831 unless otherwise provided by plan details or by Department approval.

Masonry materials shall conform to the requirements of Section 613 utilizing brick or block meeting the following requirements:

Clay or Shale - ASTM C 32 Grade SS, MS, or MM.

Concrete brick - ASTM C 55, Type I, Grade N.

Concrete block - ASTM C 90, Type I or II, Grade N.

(b) Grates and Grate Seats.

Castings shall conform to the requirements of Section 836 with attention directed to Articles 836.04, 836.05, 836.06, and 836.07. They shall be sound, smooth, clean, and free from blisters and other defects and, where necessary, planed to provide flat true surfaces.

Welded grates, grate seats, etc. shall be fabricated from ASTM A 36 material, unless otherwise denoted by plan details.

Inlet and outlet pipe shall conform to the appropriate requirements of the section of the specifications covering the kind of pipe to which they are to connect.

Grates, grate seats, etc. which are required for existing structures and are formed by welding of rolled or shaped iron shall, unless otherwise specified by plan details, comply with the following: Plates, angles, bars, etc. - ASTM A 36, Pipe - ASTM A 53; Type F, E, or S, black extra strong (X5), hydrostatic test not required.

Galvanization of grates, grate seats, nuts, bolts, and miscellaneous metal hardware, when specified on the plans, shall be hot-dipped galvanized after fabrication by one of the following methods:

Casting, grates, and seats fabricated from rolled, pressed, or forged steel shapes - ASTM A 123.

Nuts, bolts, and miscellaneous hardware - ASTM A 153.

The Department has established List I-9, "Inlet Grates and Seats for Drainage Structures and Miscellaneous Fabricated Items". This list is in the Department's manual, "MATERIAL, SOURCES AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS." Grates, grate seats and related materials shall be furnished by the approved suppliers on this list. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

621.03 Construction Requirements.

(a) Excavation.

Excavation shall be performed in accordance with the appropriate requirements set forth under Section 214, Structure Excavation and Backfill for Drainage Structures and Minor Structures.

(b) Concrete Units.

Concrete units may be either poured-in-place or precast. Construction requirements relative to the two types shall conform to the following:

1. Poured-in-place units:

   Construction shall conform to the requirements of Section 620.

2. Precast Concrete Units:

   Holes for connector pipes in base section shall be cast with connector pipe holes of the specific number and dimensions necessary to incorporate the unit into the drainage system as shown by the plans. Should installation conditions require additional pipe holes for which no holes were cast, the Contractor may make such holes as necessary provided he performs said work in a manner approved by the Engineer, and he replaces or repairs any damaged unit to the satisfaction of the Engineer.

   Pipe connections to the base sections shall be made using either concrete or masonry mortar.

   Precast bases shall be set to within 1/4 of an inch {± 10 mm} of grade on a bed of compacted foundation backfill material approximately 4 inches {100 mm} thick.

   Sectional precast sections used to form units shall have all joints sealed and wiped clean using one of the appropriate type sealers noted in Subitem 530.03(d)3.a.

(c) Masonry.

Bricks shall be laid with full mortar joints not more than 1/2 inch {10 mm} thick. Courses shall be level and at least one course in every seven shall be a header course, unless otherwise directed. All units shall be plastered on the inside of the unit with not less than 1/2 inch {10 mm} of mortar (same as used in the laying) to a height of at least 6 inches {150 mm} above the top of the outfall structure. When specified, the outside of the structure shall be plastered with 1/2 inch {10 mm} of mortar for the height of the masonry. All brick shall be dampened during laying and plastering to insure proper bond with mortar. The masonry shall be cured by approved methods which will insure the mortar has sufficiently set before allowing backfilling operations.

When so specified on the plans and/or in the proposal, masonry units may be constructed of concrete blocks instead of bricks. Applicable construction details shall be the same as for brick masonry.

(d) Inlet and Outlet Pipe.

Pipe shall be laid in accordance with the appropriate requirements of the Section of these specifications covering the kind of culvert pipe used. Pipe placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surface of the walls a sufficient distance to allow for connections, and the masonry shall be carefully constructed around them so that there will be no leakage around the outer surface of the pipe.

Pipe connections to masonry or precast units shall be made using either concrete or masonry mortar.

(e) Placing Castings.

Castings shall be set in full mortar beds or otherwise secured as shown on the plans. The mortar used for setting castings shall conform to Section 611, Mortar for Masonry. Castings shall be set below the finished grade of the pavement about 2 mm.

(f) Backfilling.

Backfilling shall be performed in accordance with the appropriate requirements of Sections 210 and 214.

(g) Cleaning.

All junction boxes, inlets, manholes, and similar structures shall be cleaned of all form material, excess mortar, and all foreign matter and shall be free from such at the time of final inspection and acceptance.

(h) Placing of Metal Grates and Seats on Structures.

Grates and seat frames shall be set in full mortar beds or otherwise secured to the masonry unit as shown by plan details. Mortar used for setting grates shall conform to the requirements of Section 611, Mortar for Masonry.

Grates installed on drainage units constructed under a previous contract shall be fitted to the unit and affixed to the structure in accordance with the details shown on the plans.

621.04 Method of Measurement.

(a) Inlets and Junction Boxes.

Inlets and junction boxes will be measured as individual units including footings, bottom slab, walls, cover, lid, grating, etc., of the type, size, and shape shown on the plans. If the height of the base unit is not shown on the plans, 4 feet {1 m} will be used as the height of the base unit. Measurements will be from the top of the bottom slab to the top of the cover, grating, or lid. Structures of greater height will have the additional height measured as noted in Subarticle (c) below.

(b) Manholes.

Manholes will be measured as an individual unit including footings, bottom slab, walls, cover, lid, grating, etc. of the type, size, and shape shown on the plans except that the maximum height of the base units of the structure shall be limited to 6 feet {2 m}, measured from the top of the bottom slab to the top of cover, grating, or lid. Structures of greater height will be measured as noted in Subarticle (c) below.

(c) Junction Box, Inlet, and Manhole Units.

Where structures of greater height than the base units noted above are provided by the plans or ordered, measurement for the additional height will be in junction box units, inlet units, or manhole units of the particular type specified by the plans or proposal. Such units will be complete wall sections of the respective type structure measured in increments of 2 feet {600 mm} in height; ordered increments of less than 2 feet {600 mm} will be considered as a complete unit.

(d) Item 621-G.

When Item 621-G is provided on the plans or proposal, the kind of inlet on which the grate will be used will be shown on the plans and the "Type" grate to be used will be designated on the plans and proposal. The accepted grates will be measured in individual units of each type ordered and accepted.

(e) Item 621-I.

When Stilling Basins, Item 621-I, are provided on the plans or proposal, measurement will be as individual units including footings, bottom slab, walls, etc., of the type, size, and shape shown on the plans.

621.05 Basis of Payment.

(a) Unit Price Coverage.

1. The accepted number of junction boxes, inlets, and manholes, measured as provided above, will be paid for at the respective contract unit prices for each, which shall be payment in full for furnishing all materials including gratings, covers, and other fittings and for all form work, disposal of surplus material, and for all labor, equipment, tools, and incidentals necessary to complete the work.

2. The accepted number of junction box units, inlet units, and manhole units, measured as provided above, will be paid for at the respective contract unit price for each type, complete in place, which shall be payment in full for furnishing all materials, for all form work, disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

3. The ordered and accepted grates under Item 621-G, measured as provided above, will be paid for at the respective unit price bid for each type specified. Said unit price shall be full compensation for the grate complete in place on the structure and includes furnishing of all materials, fabrication of the grate, installation of the grate, and for all equipment, tools, labor, and incidentals necessary to complete the work.

4. The accepted number of stilling basins, measured as provided above, will be paid for at the respective contract unit price for each type, complete in place, which shall be payment in full for furnishing all materials, for all form work, disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

(b) Excavation and Backfill.

Excavation and backfill will be paid for as provided in Section 214.

(c) Payment will be made under Item No.:

621-A Junction Boxes, Type ____ - per each
621-B Junction Box Units, Type ____ - per each
621-C Inlets, Type ____ - per each
621-D Inlet Units, Type ____ - per each
621-E Manholes, Type ____ - per each
621-F Manhole Units, Type ____ - per each
621-G Inlet Grates, Type ____ - per each
621- I Stilling Basins, Type ____ - per each

SECTION 622
RESETTING GRATINGS AND COVERS FOR CATCH BASINS, INLETS, AND MANHOLES

622.01 Description.

This Section shall cover the work of raising or lowering the covers or gratings of existing inlets, catch basins, or manholes, all in accordance with plan details and these specifications at the locations shown on the plans or directed.

622.02 Materials.

All new materials used shall be in accordance with the requirements of Section 621, plan details, and Division 800, Materials.

622.03 Construction Requirements.

Heads, covers, and/or gratings of existing manholes, inlets, or catch basins that are raised, lowered, or moved in elevation without moving the structure proper will be considered reset. All work shall be done in a workmanlike manner by competent workmen and the unit re-established in proper working order at its new elevation. Any manhole, inlet, or catch basin heads, covers, gratings, or other material broken, destroyed, lost, or rendered unfit for reuse through carelessness, negligence, or improper handling of the work, shall be replaced by the Contractor without extra compensation. Concrete and brick masonry work shall conform to requirements of Sections 620 and 613, respectively.

When adjustments to manholes, inlets, or catch basins require the removal of a portion of the existing facility, the Engineer will designate that portion of the structure to be removed. The removal of

such is considered incidental to the work and the cost included in the unit price bid for the reset item. Should the Contractor remove any portions of the structure in excess of that directed by the Engineer, he shall restore the structure to the designated removal line without additional compensation.

622.04 Method of Measurement.

Manhole covers reset and gratings reset will be measured individually as one complete unit of the base height or less as provided by the plan details. Where adjustments to the manhole covers or gratings reset exceed the base unit height, measurement and payment for the excess height will be made as provided in Articles 621.04 and 621.05 for Manhole or Inlet Units.

622.05 Basis of Payment.

(a) Unit Price Coverage.

1. Accepted manhole covers reset, measured as provided above, will be paid for at the contract unit price for Manhole Covers Reset, which shall be payment in full for all material, equipment, tools, labor, and incidentals necessary to complete the work.

2. Accepted gratings reset, measured as provided above, will be paid for at the contract unit price for Gratings Reset, which shall be payment in full for all material, equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

622-A Manhole Covers Reset - per each
622-B Gratings Reset - per each

SECTION 623
CURB, GUTTER, AND COMBINATION CURB AND GUTTER

623.01 Description.

This Section shall cover the work of constructing Portland cement concrete gutter, curb, or combination curb and gutter, constructed with or without metal reinforcement. All of which shall be constructed in accordance with the plan details and these specifications at the locations shown on the plans or established in conformity with the lines, grades, dimensions, and cross sections shown on the plans or designated.

623.02 Materials.

All materials shall conform to the requirements of Division 800, Materials. Concrete shall conform to the requirements of Section 501. Expansion joint filler shall be as specified in Section 832.

623.03 Construction Requirements.

(a) Concrete Mixes.

Concrete mixes shall be provided by Section 501, with Class A concrete being used with standard forms and either a Class A or Class C concrete mix, modified as deemed necessary by the Testing Engineer, to fit the type curbing machine being used.

(b) Foundation.

The foundation shall be constructed or excavated to the required depth below the finished surface in accordance with the cross section shown on the plans or as designated. All soft or other unsuitable material shall be removed and replaced with suitable material, in layers not to exceed 4 inches {100 mm} compacted. The foundation shall be compacted as provided for the applicable types of material involved.

(c) Foundation Backfill.

If provided by the plans and/or proposal, foundation backfill to replace unsuitable material shall be placed and constructed as provided in Section 214. No direct payment will be made for foundation backfill, except when the proposal includes a unit price for this pay item.

(d) Forms.

1. General.

The Contractor shall use standard type metal forms as noted herein or, if requested in writing and approved by the Department, an approved automatic extrusion type curb and/or gutter machine.

2. Standard Forms.

These forms shall be metal, except for radial sections, straight, and free from warps and of sufficient strength, when staked, to hold the concrete true to line and grade without distortion. They shall provide the approved typical section and depth of the section shown on the plans. Radial or curved forms may be of flexible metal or a wood form of approved design. Bent or damaged forms shall not be used.

All forms shall be securely staked, braced, and held together to the exact lines and grades established and shall be kept sufficiently tight to prevent leakage of mortar. All forms shall be cleaned and oiled with a suitable oil immediately before concrete is placed against them.

3. Machine Formed.

Any automatic extrusion type curb and/or gutter machine considered for approval must be demonstrated to produce a section conforming to the dimensions, cross-section, lines, and grades shown on the plans within the tolerances provided in Item 623.03(h)2 for formed curbs and/or gutters. Failure to consistently produce an acceptable product shall be cause to withdraw approval of the machine and order the use of standard forms. All types of curbs, gutter, and combinations shall be placed in one operation, to the depth of cross section specified on the plans. The use of a two stage operation will not be permitted.

(e) Sections.

Gutter, curb, and combination curb and gutter shall be constructed in sections of the lengths shown on the plans. The length of section may be reduced where necessary to form closure.

(f) Handling, Proportioning, and Mixing Materials.

The handling, storage, proportioning, and mixing of concrete shall conform to the requirements of Section 501.

(g) Joints.

All expansion, contraction, and construction joints shall be constructed as shown on the plans and in accordance with the requirements of Article 501.03. If not shown on the plans, joints shall be placed as follows:

1. Expansion joints shall be placed in curb and/or gutter to match those in concrete pavement where the two are adjacent.
2. Expansion joints shall be 3/4 of an inch {20 mm} wide. They shall be placed where curb, gutter or combined curb and gutter terminate against concrete driveways and other concrete structures except inlets. The joints shall be placed at least 20 feet from the location of the termination of the curb, gutter or combined curb and gutter at inlets.
3. Expansion joint filler and sealer shall meet the requirements given of Articles 832.01 and 832.02. Expansion joint filler shall extend from the bottom of the curb and/or gutter to within 1 inch {25 mm} of the top; the sealer shall be 3/4 of an inch {20 mm} thick and shall be recessed 1/4 of an inch {6 mm} from the top.
4. Contraction joints shall be placed in curb and/or gutter to match those in concrete pavement where the two are adjacent, but in no instance more than 20 feet {6 meters} between joints. The contraction joints shall be sawed or otherwise cut 2 inches {50 mm} deep by 1/8 of an inch {3 mm} wide and shall extend 2 inches {50 mm} below the pavement surface.

(h) Placing and Finishing Concrete - Standard Method.

1. Placing.

The subgrade and forms shall be checked and approved just prior to placing concrete against them. All debris or other foreign material shall have been removed from the space to be occupied by the concrete. The subgrade shall be moist but not wet or muddy. After mixing, the concrete shall be placed in the forms and shall be tamped, spaded, or vibrated sufficiently to produce a dense homogeneous mass and to bring the mortar to the surface. Particular attention shall be given to spading the concrete along and against the surface of the forms to prevent honeycombing and secure a smooth, uniform surface.

2. Strike-Off and Finishing.

When the forms are filled, the concrete shall be struck off with a template, cut to the curb edge design. The exposed concrete surface shall then be finished smooth with a wooden float in a manner that will compact the mass and produce a true, even top surface. Plastering with mortar to build up or finish will not be permitted. The surface of the gutter and the face and top of the curb shall be checked with a 10 foot {3 m} straightedge and any irregularities more than 1/4 of an inch in 10 feet {6 mm in 3 m} corrected. The alignment and grade shall not at any point vary more than 1/2 of an inch {10 mm} from that established by the elevation control stakes. Excessive troweling with a steel trowel will not be permitted. A textured finish shall be provided on the exposed surface just before the concrete becomes nonplastic by the use of a burlap or cotton fabric drag, brush, or broom which will produce a uniform gritty texture along the length of the curb, gutter, or combination curb and gutter. The upper edges of curb and gutter shall be rounded with an approved edging tool to the radius shown on the plans. The joint templates shall be set during the placing of the concrete and allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

The forms shall be left in place until the concrete has set sufficiently so that they can be removed without damage to the work, but, unless otherwise directed, they shall be removed within 24 hours after the concrete has been placed. Immediately after the removal of the forms, the repair of any minor defective areas shall be accomplished.

(i) Placing and Finishing Concrete - Machine Laid.

The requirements of Subarticle 623.03(h) are applicable except that fixed forms are not required.

(j) Curing and Protection.

Immediately after the finishing operation is completed, the concrete shall be cured as provided by Subarticle 450.03(m). If mats are used, they shall be kept continuously moist for a period of at least 72 hours. During this period, and until completion and acceptance of the work, it shall be protected from damage by the elements or other cause.

(k) Backfilling.

After the concrete has set sufficiently, spaces along the front and back sides of the gutter, curb, or combination curb and gutter, shall be backfilled to the required elevation with suitable material which shall be compacted by tamping with approved metal tamps or mechanical tamps in layers not more than 4 inches {100 mm} thick until firm and solid.

623.04 Method of Measurement.

Accepted Concrete Gutter, Concrete Curb, and Combination Curb and Gutter will be measured in linear feet {meters}, complete in place, to the nearest 0.1 foot {0.1 m} along the base of the curb face or along the flow line of the gutter continuing on such line extended across driveways, alleyways, and other entrances. Measurement for separate payment for Foundation Backfill will only be made when Item 214-B is provided in the proposal.

623.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted length of Concrete Gutter, Concrete Curb, and Combination Concrete Curb and Gutter, measured as provided above, will be paid for at the respective contract unit prices, complete in place, which shall be payment in full for all excavation, backfilling, disposal of surplus material, all joints, all special construction at driveways and other entrances and other points, furnishing all materials, hauling and placing materials, and for all labor, equipment, tools, and incidentals necessary to complete the work in accordance with the specifications including all approaches through curb and gutter indicated on the plans.

(b) Payment will be made under Item No.:

623-A Concrete Gutter - per linear foot {meter}
623-B Concrete Curb, Type ____ - per foot {meter}
623-C Combination Curb & Gutter, Type ____ - per linear foot {meter}

SECTION 624
CABLE GUIDERAIL

624.01 Description.

This Section shall cover the work of furnishing and installing posts, anchors, cables and miscellaneous hardware required for the construction of tensioned cable guiderail.

624.02 Materials and Design.

The cable guiderail system shall be a system accepted by ALDOT and determined by FHWA as passing NCHRP Report 350 or the AASHTO Manual for Assessing Safety Hardware (MASH) requirements for the Test Level, post spacing, slope, placement location, and other details as shown on the plans.

The cable guiderail system shall be designed by the manufacturer, specific to the project site, to limit the deflection to the design value shown on the plans. The manufacturer's design shall take into consideration the locations of the cable guiderail and cable guiderail runs as shown on the plans. The manufacturer shall design anchors for the beginning and ending termini of each cable guiderail run as shown in the plans and shall determine if intermediate anchors within each cable guiderail run are necessary to limit the deflection to the design value.

624.03 Construction Requirements.

(a) Submittal of the Design and Details of the Proposed Cable Guiderail System.

The Contractor shall submit 5 sets of copies of the manufacturer's system design and details to the Engineer within 14 calendar days after the date of the "Notice to Proceed".

The contract documents may include information regarding the existing soil, but it is the Contractor's responsibility to provide the cable guiderail system manufacturer with any geotechnical information needed to design the cable barrier system. The Contractor shall include the manufacturer's required soil parameters and the results of the geotechnical investigations in the submittal package.

The submittal shall include a written statement from the cable guiderail manufacturer that the proposed cable guiderail system's anchor spacing is adequate to limit the deflection to the design value shown in the plans. The manufacturer's statement shall be signed and stamped by a Professional Engineer registered in the State of Alabama.

If clarifications are required, one set of the submittal will be returned to the Contractor with comments for clarification. The Contractor will be allowed 14 calendar days to provide clarification of the submittal. The Contractor shall submit 5 sets of copies of the system design and details to the Engineer in each response to the request for clarification by the Engineer.

The Engineer will not approve the submittal but will review the submittal for completeness. The Engineer will distribute copies of the submittal when the review is complete.

(b) Contractor's Responsibility for System Installation.

The Contractor shall be fully responsible for insuring that the cable guiderail system is constructed in compliance with the cable guiderail manufacturer's recommendations and requirements.

(c) Cable Guiderail Manufacturer's Representative.

A representative of the cable guiderail manufacturer shall be present at the site of the installation during the various phases of installation to insure that the Contractor installs all components of the cable guiderail system in accordance with the manufacturer's requirements. The various phases of installation include anchor installation, line post installation, attachment to guardrail, splicing cable, cable tensioning, etc. The manufacturer's representative shall provide training for Departmental personnel applicable to the installation and maintenance procedures for all features of the guiderail. The manufacturer's representative may also be required to provide training for local first responders regarding precautions to be taken when working in and around crash sites involving the guiderail. The training sessions will be conducted at a location determined by the Engineer and will be of sufficient length to address all training topics.

(d) Letter of Compliance.

Within five calendar days after the completion of the installation of all components of the cable guiderail system, the Contractor shall submit a letter from the manufacturer to the Engineer stating that all components of the cable guiderail system, foundations, and all geotechnical conditions are in

accordance with the project specific design and manufacturer's recommendations and requirements. The cable guiderail system will not be accepted by the Department until a satisfactory letter of compliance has been received.

624.04 Method of Measurement.

(a) Cable Guiderail.

The cable guiderail will be measured in linear feet {meters} exclusive of that length of guiderail which is within the limits of measurement for the guiderail anchors. Measurement will be made from center to center of the outermost transition posts.

No separate measurement will be made of any cable, rail, post, offset block, concrete, hardware, or any other component of a cable guiderail.

(b) Cable Guiderail Anchors.

The cable guiderail anchors will be measured per each. An anchor will include all components of the cable guiderail from the terminal post to the center of the outermost transition post. No separate measurement will be made of any intermediate anchors that may be required by the manufacturer to limit the deflection to the design value.

No separate measurement will be made of any cable, rail, post, offset block, concrete, hardware, or any other component of a cable guiderail anchor.

624.05 Basis of Payment.

(a) Unit Price Coverage.

The contract prices for the cable guiderail and cable guiderail anchors shall be full compensation for submittals, soil sampling and testing, design of the anchors and sockets, all posts, foundations, hardware, materials, equipment, tools, labor, training, and incidentals necessary to complete the work.

The contract price for Cable Guiderail shall also be full compensation for all intermediate anchors and for furnishing the manufacturer's recommended tension measuring device to become the property of the Department.

(b) Payment will be made under Item No.:

624-A Cable Guiderail - per linear foot {meter}
624-B Cable Guiderail Anchor – per each

SECTION 626
CONCRETE MEDIAN STRIP

626.01 Description.

This Section shall cover the work of constructing a concrete median strip of the size, shape, and dimensions shown on the plans, at the locations, to the lines and grades shown on the plans or designated.

626.02 Materials.

All materials furnished for use shall conform to the requirements of Division 800, Materials, and Section 501.

626.03 Construction Requirements.

Concrete used in the construction of the median strip shall be Class A concrete complying with the requirements of Section 501, except that when the median strip is placed on concrete pavement, the concrete may be of the same type used in the pavement.

The median strip shall be constructed on any approved surface, normally a subbase, base, or pavement layer.

Forming, placing, finishing, and curing of the concrete shall be in accordance with the provisions of Article 623.03.

Expansion joints shall be provided as specified in Subarticle 618.03(g) for concrete driveways, unless shown otherwise by the plans or directed by the Engineer.

626.04 Method of Measurement.

Ordered and accepted concrete median strip will be measured either by linear measurement by the linear foot {meter} or volumetric measurement by the cubic yard {cubic meter} in accordance with the method of measurement designated by the pay item.

Median strips on bridges will not be measured for payment, but the volume of concrete shall be included in the concrete volume for the bridge structure.

Linear measurement of a median strip shall be the actual length of the median strip measured along the center line of the strip.

Volumetric measurement of a median strip shall be by the cross sectional average end area method unless a more accurate method of measurement is derived.

626.05 Basis of Payment.

(a) Unit Price Coverage.

The quantity of the Concrete Median Strip, measured as provided above, will be paid for at the contract unit price per foot {meter} or per cubic yard {cubic meter} for Concrete Median Strip, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

626-A Concrete Median Strip - per linear foot {meter}
626-B Concrete Median Strip - per cubic yard {cubic meter}

SECTION 629
CONCRETE MEDIAN AND SAFETY BARRIER

629.01 Description.

This Section shall cover the work of constructing a concrete median or safety barrier at the location shown on the plans, proposal, or directed. Barriers shall be basically classified as to "Type" which will designate the size, shape, height, etc. all in accordance with details shown in the plans. Barriers may be cast in place, extruded by slip form equipment, or precast and installed in a permanent manner.

This Section shall also cover the work of retrofitting concrete bridge rail in accordance with the requirements shown on the plans.

629.02 Materials.

All materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, and the following:

Concrete, unless otherwise specified by plan details, shall meet the requirements of Section 501 for Class A concrete.

Steel reinforcement shall meet the requirements of Section 502.

629.03 Construction Requirements.

(a) General.

The concrete mix, construction, placing of the concrete, curing, and finishing shall be in accordance with the appropriate provisions of Section 501, unless otherwise provided in this Section or noted in the plan details.

(b) Excavation and Backfill.

Excavation and backfill for permanent barriers shall be in accordance with the provisions of Section 214.

(c) Slip Form Method.

Barriers constructed by the use of a slip form extrusion machine shall be well compacted, dense concrete meeting all the requirements of Section 501, except for the requirement for fixed forms.

The forming portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine so that the top of the barrier can be maintained at the predetermined grade.

(d) Concrete Surface Tolerances and Finishing.

The finished concrete shall be within reasonably close conformity to the lines, grades, and dimensions shown on the plans or directed; the barrier shall present a smooth uniform appearance free from objectional cavities or projections. A 10 foot {3 m} straightedge, laid on the top faces of the barrier, shall not vary more than 0.02 foot {6 mm} from the edge of the straightedge except at grade changes and curves and be free of humps, sags or other irregularities.

Concrete surfaces shall be finished in accordance with the requirements given in Section 501 for Class 1 with exposed surfaces receiving a Class 2 coated surface finish.

(e) Joints.

Joints shall be in accordance with the provisions of Section 501, except as follows:

Surface edges on exposed vertical contraction joints shall be rounded with a 1/4 inch {6 mm} edger or sawed.

Vertical expansion joints may be open or sealed in accordance with plan requirements.

629.04 Method of Measurement.

Concrete barriers will be measured for payment by the appropriate method designated by the plans or proposal in accordance with the following:

Item 629-A – linear foot {meter} measured to the nearest 0.1 foot {0.1 m} along the top surface barrier.

Item 629-B – cubic yards {cubic meters} of concrete with volumetric measure computed by the average end area method except where results obtained differ from those obtained by a more accurate mathematical computation.

Item 629-C - unit measurement where each end section is in accordance with the size, shape, and length designated by the plans.

Item 629-D - per each in accordance with the details shown on the plans. One retrofit will be measured for each end of each concrete guardrail where the retrofit is constructed.

Item 629-E - per linear foot in accordance with the details shown on the plans.

Excavation and backfill shall be measured in accordance with the provisions of Section 214.

629.05 Basis of Payment.

(a) Unit Price Coverage.

The various "Types" of Median or Safety Barriers End Sections, and Bridge Guardrail and Rail Retrofit, ordered and accepted, measured as noted above, shall be paid for at the appropriate unit price bid provided in the proposal. Said unit price bid shall be full compensation for the furnishing of all materials and the construction of the barrier complete in place, including all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

629-A Concrete Median or Safety Barrier, Type ___ - per linear foot {meter}
629-B Concrete Median or Safety Barrier, Type ___ - per cubic yard {cubic meter}
629-C Concrete Median or Safety Barrier End Section - per each
629-D Bridge Guardrail Retrofit, Type ___ - per each
629-E Bridge Rail Retrofit, Type ___ - per linear foot {meter}

SECTION 630
GUARDRAIL AND BARRIER RAIL

630.01 Description.

This Section shall cover the work of the furnishing and installation of complete sections of steel or aluminum beam guardrail, guardrail end anchor systems, and shaped tube type barrier rail, at the locations shown on the plans or designated and in conformity with the detailed requirements of the plans and these specifications. The plans will designate the Class of guardrail to be used and, in the case of steel rail, also the Type to be used. When it is optional as to the choice of either steel or aluminum, the alternate once selected shall be used throughout the contract. Unless specified otherwise, Class A guardrail will be used for roadways and Class B guardrail will be used for bridges.

630.02 Materials.

Materials shall conform to the requirements set forth in Division 800, Materials. Specific reference is made to Section 864, Guardrail and Barrier Rail Materials, and detail drawings provided in the plans. Material will be accepted by Brand Registration and Guarantee, as provided by AASHTO M 180, and List II-17 of Materials, Sources, and Devices with Special Acceptance Requirements. Spot checks will be made for material delivered to the project. The material may be accepted or rejected based on these tests.

If alternate approved end anchors are shown to be allowed on the plans the Contractor shall obtain a copy of the details from the manufacturer prior to installation. The Contractor shall also obtain a certification from the manufacturer that the end anchors meet the "crashworthy" requirements given in the National Cooperative Highway Research Program (NCHRP) Report 350 or Manual for Assessing Safety Hardware (MASH), 2016, based upon the project requirements. The Contractor shall furnish a copy of the details and certification to the Engineer upon request.

630.03 Construction Requirements.

(a) Erection of Posts and End Anchors.

1. General.

The Contractor shall place stakes to mark the location where guardrail is required. The Contractor shall not begin the installation of the guardrail posts until the Engineer has approved the staked location of the guardrail.

2. Posts.

Unless otherwise provided by the plans or proposal, the Contractor may use one of the optional type posts shown on the plans; however, once selected, the same type shall be used throughout the contract. Posts shall be erected in such a manner that they shall be vertical with their top inside edges within 1/4 inch {6mm} of their correct position for both vertical and horizontal line. The posts shall be erected to the dimensions shown on the plans and compacted by tamping, puddling, or as directed, to obtain a rigid installation. Where posts are driven, the tops shall be protected by a suitable driving cap and the adjacent area compacted, if deemed necessary by the Engineer. If raising or other movement of the post is required, the earth shall be compacted to fill any voids caused by such movement. All posts damaged in any way during erection shall be removed and replaced without additional compensation.

3. End Anchors.

The Contractor shall use one of the Type End Anchors provided by the plans, or directed. The anchor assemblies shall be erected to the dimensions shown on the plans, and the area backfilled with suitable material and compacted as provided in Item 2 above. Posts that are attached to the anchor assembly shall be erected to the requirements for individual posts as provided in Item 2 above.

(b) Erection of Rail.

1. All metal except concrete reinforcement shall be fabricated in the shop. No punching, cutting, burning, or welding shall be done in the field. Holes for special details in exceptional cases may be made in the field when approved, after it has been demonstrated that punching will not result in damage to the surrounding metal.

2. The rail may be erected in any manner resulting in a smooth continuous rail closely conforming to the established line and grade of the surface the rail parallels. The top of the rail shall be constructed to the height designated on the plans.

3. Rail shall be erected so that the bolts at expansion joints shall be located at the centers of the slotted holes. Bolts may be rethreaded after galvanizing if necessary. All bolts, except where otherwise required at expansion joints, shall be drawn tight; however, bolts through expansion joints shall be drawn up as tight as possible without being tight enough to prevent the rail elements from sliding past one another longitudinally. Bolts shall be sufficiently long to extend at least 1/4 of an inch {6 mm} beyond the nuts. Except where required for adjustments, bolts shall not extend more than 1/2 of an inch {13 mm} beyond the nuts. Bolts through variable thickness posts shall be cut off 1/4 of an inch {6 mm} beyond the nuts and burred.

(c) Metal Treatments.

1. General.

All steel elements (posts and rail), including all accessories used in the construction of guardrail and barrier rails shall be galvanized, except when otherwise provided by the plans or proposal.

Aluminum elements (posts and rail) and accessories will require no special treatment, except where otherwise noted on the plans or proposal.

2. Steel.

a. Galvanized.

Painting of galvanized steel will not be required except that any damage to galvanizing or any bare areas developed during construction shall be painted with two coats of approved galvanizing repair paint, Section 855, or approved zinc spelter paint. However, should any galvanized metal be required by the plans or proposal to be painted, the surface shall be treated with a wash of 8 ounces {60 g} of copper or zinc sulphate dissolved in one gallon {liter} of water prior to the application of the required paint surface.

b. Not Galvanized.

All metal not galvanized shall be cleaned and painted with one primer coat and two coats of paint, Structural Steel Second and Third Coats (Section 855), unless otherwise provided on the plans or in the proposal.

3. Aluminum.

Aluminum elements of guardrail or barrier rail require no special preservative treatment unless otherwise noted on the plans.

(d) Safety of Traveling Public.

At locations where public traffic is adjacent to the guardrail or barrier rail work, all materials required to complete the work at any one location shall be available before beginning the work at that location.

Posts shall be erected only far enough in advance to permit the construction to progress consistently, uniformly, and continuously. All posts shall have the rail attached to them the same day that the posts are erected. For installations in which neither end adjoins a fixed object, the installation of the rail shall progress in the same direction as the traffic in the adjacent lane.

The intent of this specification is that each guardrail or barrier rail installation erected under traffic be completed, including end anchors and/or attenuating devices, before nightfall of the day on which work on that installation began. In the event that unforeseen conditions prevent the completion of an installation before nightfall, the Contractor will be required, at his expense, to protect and delineate the uncompleted installation by the use of reflectorized devices or other acceptable means. The minimum requirement for this protection and delineation will be one or more reflectorized drums with a Type B warning light on each drum.

If the existing guardrail or barrier rail is to be removed and reset, replaced, or relocated, then only one installation ahead of the placing operation may be removed. At any site where the rail has been removed and the new installation has not been completed, the Contractor will be required at his expense to protect the site with reflectorized drums, with a Type B warning light on each drum, as shown on the plans or directed by the Engineer.

630.04 Method of Measurement.

Posts will not be measured for payment separately. The length of the beam guardrail or barrier rail constructed and accepted will be measured in linear feet {meters} to the nearest 0.1 foot {0.1 m} from the end of each continuous installation, exclusive of designated anchor assemblies along the centerline of the top of the rail posts for guardrail and of the rail element for barrier rail.

Standard guardrail installations cover one rail element, its supports (post) and accessories. When installations are to cover special installations such as double-faced rail (two rail elements) mounted on a single post, a separate pay item will be provided and the special condition so noted in the description of the pay item.

End Anchor Assemblies shall be measured separately in individual unit assemblies, complete in place, including all hardware and accessories to complete the type anchor assembly ordered placed in accordance with plan details.

630.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted guardrail or barrier rail, measured as provided above, will be paid for at the contract unit price bid per linear foot {meter} for Beam Guardrail or Barrier Rail which shall be payment in full for excavating, backfill, disposal of surplus material; for furnishing, transporting, erecting of posts and

rail; for all incidental material, bolts, brackets, etc., as shown on the plans; and for all equipment, tools, labor, and incidentals necessary to complete the work.

Accepted Guardrail End Anchor Assemblies, measured as provided above, will be paid for at the contract unit price per each, which shall be full compensation for excavating, backfilling, disposal of surplus materials, for furnishing, erecting the anchor assembly, and all incidental materials necessary to install the assembly, complete in place, as shown on the plans, and for all equipment, tools, labor, and incidentals necessary to complete the work.

Accepted steel beam guardrail for culvert, measured as provided above, will be paid for at the contract unit price bid per linear foot {meter} which shall be payment in full for excavating, backfill, and disposal of surplus material; for furnishing, transporting, and erecting of posts and rail; for saw cutting and epoxy coating the parapet; for all bolts, brackets, bases, and hardware including any required drilling for installation; and for all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

630-A Steel Beam Guardrail, Class ____ , Type ____ - per linear foot {meter}
630-B Aluminum Beam Guardrail, Class ____ - per linear foot {meter}
630-C Guardrail End Anchor, Type ____ - per each
630-G Steel Beam Guardrail for Culvert, Class ____, Type ____Case ____ per linear foot {meter}

SECTION 631
GUARDRAIL OR BARRIER RAIL RELOCATED

631.01 Description.

This Section shall cover the work of relocating guardrail or barrier rail and end anchor systems to the established lines and grades at the locations shown by the plans or directed, in conformity with the plans and these Specifications. The relocation shall include the removal, reconditioning, and reinstallation of the rail, posts, hardware, and anchor systems.

This Section shall also cover the adjustment (reset) of existing guardrail.

631.02 Materials.

(a) Salvaged Material.

All portions of the rail elements, posts, and other hardware designated to be reset or relocated shall be cleaned and inspected. Damaged portions shall be discarded or repaired as directed.

Damage to galvanization on metal (steel) portions shall be repaired with approved galvanizing repair paint.

Posts and rail elements shall be cut or drilled to conform to the requirements of the current plan requirements for the type rail being used.

Timber posts shall be coated with one liberal coat of the type preservative used in the original treatment, unless the use of another type preservative is authorized by the Engineer. Galvanized steel posts which cannot be repaired satisfactorily with galvanized repair paint shall be painted with an approved aluminum paint.

(b) New Materials.

New materials shall meet the requirements specified in Section 864, Guardrail and Barrier Rail Material. Paint shall meet the requirements of Section 855, Coatings, Paints, Enamels, and Varnishes for Metal or Wood Structures.

631.03 Construction Requirements.

(a) General.

The Contractor shall promptly replace, without extra compensation, any materials lost, damaged, or injured on account of carelessness, negligence, or failure to conduct the work properly. Any such replacements shall be with materials conforming to the original material requirements.

Should any of the rail, posts, or end anchors included in the relocation or reset items be deemed, by the Engineer, unsuitable for reuse through no fault or negligence of the Contractor, the Engineer may either furnish materials acceptable for use or may require the Contractor to furnish new materials.

Payment for such new rail, posts, or end anchors, but not hardware, will be made as for unused materials outlined in Subarticle 109.06(b).

Attention is directed to the fact that this type work will be performed under traffic requiring special care to expedite the work and prevent undue hazardous conditions to occur during the operation. Attention is directed to the requirements of Subarticle 630.03(d).

(b) Post Replacement.

Post replacements shall be made with salvaged posts from other sources until exhausted. All new replacement posts shall, if practicable, be placed together in selected sections of guardrail constructed in accordance with current standard plans, and shall, to the extent practicable, be of the same type and size as the salvaged posts.

(c) Installation.

Installation shall be in accordance with the provisions of Article 630.03.

(d) Guardrail Reset and Guardrail End Anchor Reset.

These items shall be completed in accordance with the requirements shown on the plans or as directed by the Engineer.

631.04 Method of Measurement.

Guardrail or Barrier Rail Relocated will be measured in linear feet {meters} along the face of the rail to the nearest 0.1 foot {0.1 m} from end to end of each continuous portion of rail relocated,

Guardrail End Anchors Relocated will be measured in individual unit assemblies, complete in place, of the type designated, relocated to the satisfaction of the Engineer.

Guardrail Reset will be measured in linear feet {meters} along the face of the rail to the nearest 0.1 foot {0.1 m} from end to end of the section of guardrail to be reset.

Guardrail End Anchor Reset will be measured per each.

631.05 Basis of Payment.

(a) Unit Price Coverage.

1. Guardrail and Barrier Rail Relocated.

Accepted guardrail or barrier rail relocated, measured as provided above, will be paid for at the contract unit price bid per linear foot {meter} for the type rail to be relocated which shall be payment in full for removing the in place rail and posts, preparing the rail, posts, and hardware for relocation, and for the installation of the posts, rail, and accessories.

The above unit prices shall include furnishing any additional necessary hardware, equipment, tools, labor, and incidentals necessary to complete these items of work. Any new rail or posts required to replace damaged rail or posts, through no fault of the Contractor, shall be furnished by the Contractor with payment to be made the same as for unused materials outlined in Subarticle 109.06(b).

2. Guardrail End Anchor Relocated

Accepted guardrail and anchors relocated, measured as provided above, will be paid for at the contract unit price bid per each, which shall be payment in full for removing the in place anchor system, preparing the anchor system and accessories for relocation, and for the installation of the complete assembly. The unit price bid shall include any additional hardware, equipment, tools, labor, and incidentals necessary to complete this item of work. Any new end anchor required to replace an unserviceable end anchor will be paid for as for unused materials outlined in Subarticle 109.06(b).

3. Guardrail Reset

Accepted guardrail reset, measured as noted above, will be paid for at the contract unit price bid per linear foot {meter} for the type rail to be reset which shall be payment in full for all equipment, tools, labor, blockouts, and additional hardware required to complete the work. Any new rail or posts required to replace damaged rail or posts, through no fault of the Contractor, shall be furnished by the Contractor with payment to be made the same as for unused materials outlined in Subarticle 109.06(b).

4. Guardrail End Anchor Reset

Accepted guardrail end anchor reset, measured as noted above, will be paid for at the contract unit price bid per each and shall be payment in full for all equipment, tools, labor, hardware, and incidentals needed to complete the work. Any new end anchor required to replace an unserviceable end anchor will be paid for as for unused materials outlined in Subarticle 109.06(b).

(b) Payment will be made under Item No.:

631-C Guardrail Reset – per linear foot {meter}

631-E Guardrail End Anchor __**__ Reset – per each

631-F __**__ Relocated - per linear foot {meter}

631-G Guardrail End Anchor __***__ Relocated - per each

* Steel Beam Guardrail Class ____ , Type ____ ; Aluminum Beam Guardrail Class ____ Steel Rectangular Tube, Barrier Rail; Extruded Aluminum Tube, Barrier Rail

** Type 1, 2, 3, etc.

SECTION 632
HEADLIGHT GLARE SCREEN

632.01 Description.

This Section shall cover the work of furnishing and erecting headlight glare screens in accordance with the details shown on the plans and as specified herein at the locations shown on the plans or designated. Where optional types are permitted, the same type, once selected, shall be used throughout the project.

632.02 Materials.

Materials furnished for use shall meet the requirements of Division 800, Materials, and the requirements noted in the plans.

632.03 Construction Details.

All construction methods and equipment employed in installation of the headlight glare screen shall be in accordance with the requirements shown on the plans and those of the manufacturer of the materials being used and good erection practices, so that the resulting structure will provide the expected service and be complete in every detail.

Headlight glare screen may be supported by ground-mounted posts or posts attached to guardrail posts, rectangular tubing barrier rail, along the top of the concrete median barrier wall or other special mounting as shown on the plans.

632.04 Method of Measurement.

Quantities of Headlight Glare Screen to be paid for will be determined by the linear foot {meter} from actual measurements along the line of the completed headlight glare screen.

632.05 Basis of Payment

(a) Unit Price Coverage.

The accepted quantity of Headlight Glare Screen, measured as provided above, will be paid for at the respective contract unit bid price for each separate type of mounting. The said unit price shall be payment in full for furnishing all materials and for all labor, tools, equipment, and incidentals necessary for performing all work involved in constructing the headlight glare screens, complete in place, in accordance with the details shown on the plans.

When plans show the Headlight Glare Screen to be mounted on existing facilities, the unit bid price shall also include the necessary drilling, welding, and/or other special treatment of the existing facility for satisfactory attachment of the posts.

(b) Payment will be made under Item No.:

632-A Headlight Glare Screen, (* Type of Mounting) - per linear foot {meter}

* Example: Ground mounted; Mounted on Guardrail Posts; Mounted on Barrier Rail, Rectangular Tubing; or Mounted on Concrete Median Barrier.

SECTION 634
CHAIN LINK INDUSTRIAL FENCE

634.01 Description.

This Section shall cover the work of furnishing and installing, complete in place, commercial chain-link fence on posts and frames with either standard ground mounting or mounted on structures (bridges, retaining walls, etc.) as required by the plans, at locations shown on the plans or designated, all in accordance with the details shown on the plans and these specifications.

634.02 Materials.

(a) General.

All materials shall conform to the requirements of Division 800, Materials, and shall be in accordance with details shown on the plans. Special attention is directed to Section 871.

(b) Special Mounted Fence.

When the fence is to be installed on structures which cannot utilize the standard method provided by the regular fence drawings, the type of post installation, etc., will be shown on the plans. Requirements for such installations will be shown on the plans. All miscellaneous steel used in such installations or mounting assemblies shall be of ASTM A 36 steel or approved equal and galvanized in accordance with ASTM A 123, unless such is otherwise provided by the plans.

634.03 Construction Requirements.

(a) General.

All construction methods and equipment employed in the setting of fence shall be in accordance with requirements of the specifications of the manufacture of the fence materials being used and such that the resulting structure will provide the expected service and be durable and complete in every detail.

(b) Clearing Fence Line.

All brush, stumps, logs, large roots, humps of earth, boulders or debris which would interfere with proper construction of the fence in the required location and present a pleasing and acceptable profile along the tops of posts shall be removed before starting fencing operations. Sound standing trees in the fence line shall be removed or trimmed as directed to provide adequate working room. The clearing and/or grading of the fence line and the disposal of material removed shall be accomplished in such a way that trees and shrubs on the remainder of the right of way will not be damaged.

Breaks in profile of the fence shall be spread over vertical curves of sufficient length to insure a pleasing appearance.

(c) Setting Posts.

Posts and anchorages shall be set at intervals shown on the plans or directed. The posts shall be set plumb and true in alignment on the side which the fabric is to be attached. All end and corner posts, brace posts, pull posts and gate posts shall be set in concrete in accordance with plan details. Line posts may be set in place by one of the following methods: (1) set in concrete in the same manner detailed in the plans for brace posts, (2) driven, provided soil conditions are suitable and full embedment depth is obtained. When posts are driven, methods shall be used to protect the posts from damage due to driving operations. Damaged posts shall be repaired as directed or removed and replaced without additional cost to the State, Regardless of the installation method used, a stable fence frame shall be obtained. Where unstable soil is encountered, the use of longer posts, concrete anchorage or other approved post stabilization methods shall be required. Where fence is over solid rock or other hard unyielding material is encountered, special treatment may be authorized.

When installing fence through areas where other than ground installations are required, special attention shall be given to the attachment of the mounting assemblies to the structure. Anchor bolts, etc. shall be cast into structures wherever possible. Other types of attachments, if permitted by the plans, must be approved by the Engineer before use. In any event, anchorage must be so installed as to present a neat workmanlike appearance.

(d) Constructing Fence.

Chain link fence shall be stretched taut and securely fastened to each post by means of approved metal bands or No. 9 gage {3.75 mm} wire spaced not more than 12 inches {300 mm} apart on posts and

not more than 15 inches {375 mm} apart on the rail. The method of attaching at end posts, gates, and corner posts shall be as shown on the plans.

If barbed wire is specified on the plans, the barbed wire, barbed wire arms, and method of attachment shall be as shown on the plans. Wires shall be stretched taut and spaced as shown on the plans.

634.04 Method of Measurement.

The quantity of chain link fence of each separate height and variation shall be the accepted lengths, exclusive of gates, measured along the top rail overall in linear feet {meters} to the nearest foot {0.1 m}, complete in place. The quantity of gates shall be the actual accepted number of gates classified according to type and width of gates.

When the item of Protective Cage (Industrial Fence) is provided in the Plans or Proposal, the accepted Protective Cage shall be the complete cage structure installed in accordance with plan details for the designated bridge type structure.

634.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted quantity of fence, measured as provided above, will be paid for at the respective contract unit prices of each separate height and variation, complete in place, which shall be payment in full for all preliminary clearing, grubbing, excavating, and filling; for all materials, including concrete for posts, hardware, fittings and appurtenances; for erecting, bracing and aligning, and for all equipment, tools, labor and incidentals necessary to finish and complete the work. The accepted number of gates of each size measured as provided above will be paid for at the respective contract unit prices, complete in place, which shall be payment in full for furnishing and erecting all materials, all hinges, braces and other necessary fittings, including lock, 2 keys and one master key for each gate, and for all equipment, tools, labor and incidentals necessary to finish and complete the work.

When the item of Protective Cage (Industrial Fence) is provided in the plans or proposal, the accepted complete unit, measured as noted above, will be paid for at the contract lump sum price for each respective unit, complete in place, which shall be payment in full for furnishing all materials, fabrication and erection of all pipe framework including the connectors and inserts necessary for the installation of the fabric, and for all equipment, tools, labor and incidentals necessary to finish and complete the work.

(b) Payment will be made under Item No.:

634-A Industrial Fence, ___ feet {m} High - per linear foot {meter}
634-B Industrial Fence, ___ feet {m} High, plus Barbed Wire, (45° Arms) - per linear foot {meter}
634-C Industrial Fence, ___ feet {m} High, plus Barbed Wire (Vertical Arms) - per linear foot {meter}
634-D Gate, ___ feet {m} Wide, Complete with Fittings (With Barbed Wire) or (Without Barbed Wire) - per each
634-E Industrial Fence ___ feet {m} High, Special Mounting - per linear foot {meter}
634-F Protective Cage (Industrial Fence) - per lump sum

SECTION 635
WOVEN WIRE FENCE

635.01 Description.

This Section shall cover the work of furnishing and erecting fences of woven wire and barbed wire, together with appropriate gates. Posts shall be wood or metal in accordance with details shown on the plans and/or proposal. Fences shall be erected at the locations and elevations shown on the plans or designated and shall comply with these Specifications. When it is optional as to the choice of the post type to be used, the alternate, once selected, shall be used throughout the project.

635.02 Materials.

Materials shall conform to requirements of Division 800, Materials, with specific reference to Section 871, and the details shown on the plans.

635.03 Construction Requirements.

(a) General.

All construction methods and equipment employed in the setting of fence shall be in accordance with requirements of the Specifications of the manufacturer of the fence materials being used and such that the resulting structure will provide the expected service and be durable and complete in every detail.

(b) Clearing Fence Line.

All brush, stumps, logs, large roots, humps of earth, boulders or debris which would interfere with proper construction of the fence in the required location and present a pleasing and acceptable profile along the tops of the posts shall be removed before starting fencing operations. Sound standing trees in the fence line shall be removed or trimmed as directed to provide adequate working room. The clearing and/or grading of the fence line and the disposal of material removed shall be accomplished in such a way that trees and shrubs on the remainder of the right of way will not be damaged.

(c) Setting Posts.

All posts and anchorage shall be set at intervals shown on the plans, or directed. The posts shall be set plumb and in true alignment on the side on which the wire is attached. Holes shall be dug to the minimum diameter and depth shown on the plans except that special treatment may be authorized when the fence is over solid rock. Steel or wood posts, excluding posts that are to be set in concrete, may be driven if the soil conditions are suitable. Methods shall be used to protect the posts and galvanized coating or wood preservative during the driving operation. The heads of all posts shall be protected from damage by caps or driving heads of approved design. Heads of wood posts shall be protected by a suitable cushion of wood, rope or like material and by a metal driving head. Posts that are damaged in any way shall be removed and replaced without additional cost to the State.

(d) Installing Wire and Gates.

The woven wire fabric shall be stretched taut and securely fastened to each post by use of wire and an approved fencing tool so that the top of the fabric and lines of barbed wire are properly spaced from the top of each post as shown on the plans. The stretching shall be done with an approved stretcher that will produce equal tension in each line of wire in the fabric. At each end, corner or gate post each strand or line of wire shall be wrapped around the post and securely fastened near the post by winding the end about the same wire.

Where the fence crosses short depressions, longer posts may be required and the space below the bottom of the fence filled in with additional strands of barbed wire tied to posts as directed.

Where the fence crosses deep depressions or ravines the Engineer shall require that posts likely to be lifted when the fence is stretched be anchored in concrete as required for corner posts.

The fence shall be connected to culvert and/or bridge wing walls in accordance with the details shown on the plans.

The Contractor, however, may submit for consideration by the Department an alternate method of attaching the fence to the wing walls, provided no additional cost to the project is incurred, the method submitted presents a pleasing appearance to the eye, and accomplishes the desired results.

635.04 Method of Measurement.

All woven wire fences completed in compliance with these specifications at designated locations and accepted will be measured in place, along the top of the posts overall between the extreme limits of each section, excluding gates, in linear feet {meters} to nearest foot {0.1 m}. Each gate completed in compliance with the plans and these specifications and accepted will be counted as a unit, complete in place.

635.05 Basis of Payment.

(a) Unit Price Coverage.

1. Fences constructed and measured as above provided will be paid for at the contract unit price per linear foot {meter} for Woven Wire Fence completely in place, which shall be payment in full for clearing, grubbing, and preparatory shaping for the fence line; for disposing of waste materials; for excavating for posts and braces and pouring concrete foundations where required; for furnishing all materials; for setting posts and braces, installing wire and other incidentals and for all equipment, tools and labor required to complete the work.

2. The accepted number of gates of each width constructed and accepted as above provided will be paid for at the respective contract unit prices for each width, which shall be payment in full for

furnishing and installing gates together with all necessary fittings, hinges, braces, locks, keys, and other specified accessories, and for all materials, equipment, tools and labor necessary to complete the work.

(b) Payment will be made under Item No.:

635-A Woven Wire Fence - per linear foot {meter}
635-B Gate, ___ feet {m} Wide - per each

SECTION 636
BARBED WIRE FENCE

636.01 Description.

This Section shall cover the work of furnishing and erecting barbed wire fences of the type and size shown on the plans and/or proposal. Posts shall be wood in accordance with details shown on the plans and/or proposal. Fences shall be erected at the locations and elevations shown on the plans or designated and shall comply with these specifications.

636.02 Materials.

Materials shall conform to requirements of Division 800, Materials, with specific reference to Section 871 and the details shown on the plans.

636.03 Construction Requirements.

(a) Clearing Fence Line.

All brush, stumps, logs, large roots, humps of earth, boulders or debris which would interfere with proper installation of fence in the required location and present a pleasing and acceptable profile along the tops of posts shall be removed before starting fencing operations. Sound standing trees in the fence line shall be removed or trimmed as directed to provide adequate working room. The clearing and/or grading of the fence line and the disposal of material removed shall be accomplished in such a way that trees and shrubs on the remainder of the right of way will not be damaged.

(b) Setting Posts.

All posts and braces shall be set to the required depths and intervals. The posts shall be set plumb and in true alignment on the side on which the wire is attached. Holes shall be dug to the minimum diameter and depth shown on the plans except that special treatment may be authorized when the fence is over solid rock. Posts may be driven if the soil conditions are suitable. Methods shall be used to protect the posts during the driving operations. The heads of all posts shall be protected by a suitable cushion of wood, rope or like material and by a metal driving head. Posts that are damaged in any way shall be removed and replaced without additional cost to the State. The backfill shall be well tamped into place.

(c) Installing Wire.

The barbed wire shall be stretched taut and securely fastened to each post by use of wire or staples and an approved fencing tool so that the lines of barbed wire are properly spaced on each post as shown on the plans. The stretching shall be done with an approved stretcher that will produce equal tension on each line of wire. At each end or corner post each strand or line of wire shall be wrapped around the post and securely fastened near the post by winding the end about the same wire.

Where the fence crosses short depressions, longer posts may be required and the space below the bottom strand of the fence filled with additional strands of wire tied to the posts as directed.

636.04 Method of Measurement.

All barbed wire fences completed in compliance with these specifications and details shown on the plans at designated locations, and accepted will be measured in place along the top of the posts in linear feet {meters} to the nearest 0.1 foot {0.1 m}.

636.05 Basis of Payment.

(a) Unit Price Coverage.

Barbed Wire Fences constructed and measured as provided above will be paid for at the contract unit price per linear foot {meter} for barbed wire fence complete in place, which shall be payment in full for clearing, grubbing and preparatory shaping for the fence line; for disposing of waste materials,

for excavating for posts and braces; for furnishing all materials; for setting posts and braces, installing wire and other incidentals and for all equipment, tools, and labor required to complete the work.

(b) Payment will be made under Item No.:

636-A Barbed Wire Fence, ____ Strands ____ feet {m} High - per linear foot {meter}

SECTION 637
FENCE RESET

637.01 Description.

This Section shall cover the work of the resetting of fences, gates, stiles and cattle chutes, required to be removed from their original position inside the right of way, or erecting fence, gates, etc. using new material of the type furnished to the Contractor (usually by the owner of the abutting land) instead of materials removed from the right of way.

637.02 Materials.

Existing materials shall be utilized to the fullest extent possible; replacements for materials damaged or destroyed due to negligence on the part of the Contractor shall be of at least the same grade of material used in the original fence. Approval of the replacement material shall be made by the Engineer; no testing of this material will be required unless such is ordered by the Engineer.

637.03 Construction Requirements.

(a) General.

Attention is directed to the general construction requirements for construction of Chain Link Industrial Fence, Section 634; Woven Wire Fence, Section 635; and Barbed Wire Fence, Section 636.

The Contractor will be required to remove and reset the fence to the location on and beyond the right of way lines as designated, using the material from the original fences, and shall leave all fences in as good condition as before removal from their original location.

In case resetting of a fence will completely re-enclose a previously enclosed area, the Contractor shall be responsible for all damages of any nature arising from the removal of the fence or delay or negligence in resetting. No such fence shall be cut or disturbed until the Contractor has made adequate provision for immediate repair or reconstruction. Watchmen to control livestock where fence is being reset shall be provided by the Contractor as necessary without extra compensation.

In case resetting of a fence will not re-enclose a previously enclosed area, it shall not be cut or moved without a written order from the Engineer. Pending issuance of such written order, the Contractor will be permitted to install at his expense, temporary fences and gates or other means of access. The Contractor, provided reasonable caution is used, will not be held responsible for damage arising from removing and resetting fence after receiving a written order for its removal.

(b) Installation.

Reset fences shall be true to line and grade with all wires taut and well fastened, and shall present a workmanlike appearance.

(c) Gates.

All gates shall be moved and made serviceable at the new location. All damage to fence and gates due to moving operations shall be repaired by the Contractor. All posts and gates not in serviceable condition shall be replaced with posts and gates of serviceable materials. The cost of such replacements shall be included in the price bid for Fence Reset and no direct payment will be made for such replacements.

The Contractor will not be required to furnish any additional material, except posts and gates, as above provided, and such materials as may be necessary to replace any and all parts of the fence and gates unnecessarily damaged in removing and handling and resetting. Should the owners or the lessees of the abutting property desire to improve any fence or portion thereof which is designated to be reset, and the said owners or lessees agree to furnish the Contractor, at the site of the work, the necessary material similar in character to that in the original fence, the Contractor will be required to rebuild and reset such fence using the material furnished by the owners or lessees in lieu of the original material. The Contractor will be responsible for such materials delivered on the site until incorporated in the fence. The original material so replaced may be recovered by the owners or lessees.

(d) Fence Set.

When the item of "Fence Set" is included in the plans or proposal, the Contractor shall use the fencing materials which have been placed along the right of way at designated locations, and construct a fence along the right of way making the necessary connections to existing or reset fences. Construction details shall be the same as required for reset fence.

637.04 Method of Measurement.

The quantity of fence reset or fence set shall be the accepted net length, including gates, of completed fence removed and reset or of fence set at the new location, measured along the top of the post line in linear feet {meters} to the nearest foot {0.1 m}. No measurement or direct payment will be made for fence removed only and not reset. The quantity of fence reset includes cattle chutes, stiles, and related fences.

637.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted quantity of fence reset will be paid for at the contract unit price bid per linear foot {meter} for Fence Reset, which shall be payment in full for furnishing all labor, material, equipment, tools, and incidentals necessary to complete the work.

The accepted quantity of fence set will be paid for at the contract unit price bid per linear foot {meter} for Fence Set, which shall be payment in full for furnishing all labor, equipment, tools and incidentals necessary to complete the work, including responsibility for the new materials furnished until used.

(b) Payment will be made under Item No.:

637-A Fence Reset - per linear foot {meter}
637-B Fence Set - per linear foot {meter}

SECTION 640
MINOR UTILITY ADJUSTMENTS

640.01 Description.

This Section shall cover the work of minor adjustments and/or relocations of various types of public or private utilities, that may be encountered within the construction limits of the project, from their original location in order to clear the construction and comply with existing State laws.

640.02 Materials.

In the adjustment of utilities under this Section the Contractor shall use materials salvaged from the original facility plus new materials necessary to clear the construction of these facilities. All new materials and accessories necessary to adjust and/or relocate these facilities shall be furnished by the Contractor with like material of at least equal quality of that in place.

640.03 Construction Requirements.

The construction methods employed in the adjustment or relocation of the various types of utilities shall be in accordance with current local codes and practices of the type utility involved.

The Contractor shall be required to adjust and/or relocate the various types of utilities, which may be encountered, as shown on the plans or directed, using the material salvaged from the original facility plus any new material necessary to clear the construction.

All salvable and unsalvable material not used in the adjustment of the facility involved shall become the property of the Contractor, unless otherwise provided by the plans, and shall be disposed of by him off the limits of the right of way at his discretion.

Work required for this adjustment shall be performed by the Contractor in a manner that will limit interruption of the services for the utility involved a minimum period of time.

When adjusting, installing or otherwise working with non-metallic conduits for underground utilities, the Contractor shall install on the conduit a metallic tape or provide other suitable means whereby the installation can be relocated by electronic detection devices.

640.04 Method of Measurement.

Each type of utility, either overhead or underground, to be adjusted and/or relocated for which direct payment is to be made will be designated on the plans or in the proposal. For the purpose of measurement and payment each type of utility will be classified separately. The method of measurement shall be as noted herein with measurements either per linear foot {meter} or per lump sum with each being measured as complete in place. Measurements in linear feet {meters} will be to the nearest foot {0.1 m}, along the centerline of the type utility being measured.

640.05 Basis of Payment.

(a) Unit Price Coverage.

Payment for the utility adjustment, measured as noted above, will be made at the contract unit price bid per type utility which shall be payment in full for the adjustment as provided on the plans or proposal. Said contract unit price bid shall be payment in full for all materials, equipment, tools, labor and incidentals necessary to complete the adjustment of the utility and restore the service of the type utility involved.

The unit price bid for underground utility adjustment will be based on placing the facility at a depth of 3 feet {1 m} or less under the existing ground surface, unless otherwise noted on the plans.

The accepted footage of underground facilities complete in place at depths greater than 3 feet {1 m} below the ground surface shall have an adjusted unit price, arrived at by increasing the contract price bid by the percentage indicated in the table below. Unit price coverage noted in paragraph 1 above shall govern for such adjusted unit price.

Final acceptance of this work will be subject to approval by the Utility Company involved; therefore, the Engineer may withhold payment for this work until the Contractor has obtained the owner's written approval that the work performed complies with the local codes and requirements of the Utility Company.

Depth Utility Installed Below Existing Ground Line	Percentage Contract Unit Price Bid to be Increased
More than 3 feet {1 m}, but less than 6 feet {2 m}	20
6 feet {2 m} and more, but less then 9 feet {3 m}	50
9 feet {3 m} and more, but less than 12 feet {4 m}	75
12 feet {4 m} and more	100

(b) Payment will be made under Item No.:

640-A __*__ Utility Adjustment (__**__) - per linear foot {meter}
640-B __*__ Utility Adjustment (__**__) - per lump sum

* Overhead or Underground
** Electrical, Communication (Telephone/Telegraph), Gas, Water or Sewerage

NOTE: Types of Utilities in general will be classified as Electrical, Communication (telephone or telegraph), Gas, Water or Sewerage.

SECTION 641
WATER LINE

641.01 Description.

This Section shall cover the work of the following:

- furnishing and installing new water pipe, water mains, water meters and boxes, valves and valve boxes, fire hydrants, and appurtenances;
- removing, relaying and resetting existing water pipe, water mains, water meters and boxes, valves and valve boxes, fire hydrants, and appurtenances;
- constructing connections to existing water mains.

A water service line shall be defined as a lateral line leading from a water main to a building.

A water main shall be defined as the carrier pipe through which water is transmitted from the water source to the water service lines.

All work performed and materials used shall be in accordance with the ALDOT plans and specifications and the Utility's requirements. In the event that there is a conflict between the ALDOT plans and specifications and the Utility's requirements, the more stringent requirements shall govern.

641.02 Materials.

Materials furnished for use shall conform to the requirements of Section 863 and other appropriate Sections of Division 800, Materials.

Concrete used for thrust blocks shall be in accordance with the requirements given in Section 620.

641.03 Construction Requirements.

(a) General.

1. Water Pipe.

Pipe shall be laid in the presence of the Engineer. Pipe shall not be covered until allowed by the Engineer. Pipe designated to be relaid that is damaged or rendered unfit for use through negligence or improper handling by the Contractor shall be replaced by the Contractor without additional compensation.

All new pipes shall be handled in such a manner as to prevent damage to the pipe and pipe lining. The interior of all pipes, valves, and fittings shall be free from dirt and debris. All material shall be stored in the appropriate manner to protect the materials from damage by freezing and subsequent handling.

The construction methods employed in the adjustment, relocation, and placement of the water pipe shall be in accordance with the current codes and practices of the Utility Company involved.

Work required for the adjustments of a water main and service line shall be performed by the Contractor in such a manner that shall limit interruption of the service for a minimum period of time. Notice shall be made by the Contractor to the Customers affected by the service interruption at least 4 hours but not more than 72 hours prior to service interruption.

When ductile iron water pipe and fittings are located in potentially corrosive soil conditions, the pipe shall be wrapped in polyethylene sheath meeting AWWA C105.

When installing non-metallic water pipe, the Contractor shall install a metallic tape or locating wire on the pipe or provide other suitable means approved by the Engineer to allow for location by electronic detection devices.

Valves and other controls on the existing water system shall not be operated for any purpose by the Contractor without approval and representation by the Utility.

Water mains shall be laid below existing drainage pipes, existing water lines, gas lines, and other utility lines except for sanitary sewer by deflecting pipe downward unless otherwise shown on the plans or approved by the Engineer. Any deflection shall be approved by the Engineer and in accordance with the pipe manufacturer's recommendations.

PVC pipe installation shall meet the requirements of ASTM D 2321.

HDPE pipe used for the open cut method shall meet the manufacturer's requirement for the pressure rating required for use.

2. Hydrant.

All hydrants shall meet the requirements of AWWA C502 and traffic model design. All hydrants shall be thoroughly cleaned of dirt or foreign matter before setting. Locations of hydrants will be determined by the Engineer.

Hydrants shall be located for complete accessibility and to avoid damage from vehicles and injury to pedestrians. All hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the curb.

Each hydrant shall be controlled by an independent gate valve. A drainage pit 2 feet x 2 feet x 2 feet {0.6 m x 0.6 m x 0.6 m} shall be excavated below each hydrant and filled with coarse gravel or crushed stone to a depth of 6 inches {150 mm} above the hydrant opening. The drainage pit shall not be connected to a sewer system. The bowl of each hydrant shall be anchored as approved by the Engineer.

Each fire hydrant unit shall include 3 feet of piping to attach to the water line. Fire Hydrant Extensions shall be installed to connect the standard fire hydrant unit as shown on the plans to the water line when the line is deeper than the standard 3 foot fire hydrant piping attachment.

3. Valves.

All valves shall meet the requirements of AWWA C500. All valves shall close when the nut is turned clockwise. All valves shall have a non-rising stem.

Gate valves shall be plumb and shall be set and jointed to the new pipe as specified for laying pipe.

Cast Iron valve boxes shall be plumb and centered over the wrench nut of the valve with the box cover flush with the finished pavement or unpaved area.

Air release valves shall be installed where shown on the plans.

4. Retainer Gland.

Retainer glands shall be the type shown on the plans or designated by the Engineer and shall be installed in accordance with the Utility Company requirements.

5. Water Meter and Box Reset.

The water meter box shall be adjusted carefully to the designated location and elevation. Backfill shall be tamped around each box located in the pavement area to the required density of the adjacent material. Any meter, box or accessories lost or rendered unfit for re-use due to negligence or improper handling by the Contractor shall be replaced in kind without additional compensation.

6. Valve Box Reset.

A valve box shall not be reset until approved by the Engineer. The box shall be adjusted carefully to make sure that the top is at the designated location and elevation. Backfill shall be tamped around each box located in the pavement area to the required density of the adjacent material. Any box or accessories lost or rendered unfit for re-use due to negligence or improper handling by the Contractor shall be replaced in kind without additional compensation.

7. Line Stop.

A line stop to stop the flow of water in a portion of the main without interruption of water service shall be manufactured and installed by either T.D. Williamson, Inc., Severn Trent(Hydra-Stop), IPSCO, or an Engineer approved equal. The line stop and appurtenances shall be pressure rated for a minimum of 150 psi to safely cease the flow of water in the existing water main. The line stop shall be designed for the water main material shown on the plans and field verified prior to installation. The thrust restraint shall be as detailed in the project plans. The Contractor performing the installation of the line stop shall have successful experience in water main tapping and line stopping.

(b) Excavation and Foundation.

The trench shall be excavated to the designated line and grade. The trench width shall be sufficient to permit work on the pipe and inspection of the work. Mains shall have a minimum trench width of 18 inches {460 mm} plus the outside diameter of the pipe with the depth sufficient to provide for foundation preparation and proper cover. Trenches shall be properly sheeted or braced wherever needed to prevent cave-in or loose soil from falling into the trench. Sides of the trenches shall be kept as near vertical as possible. Bell holes shall be excavated to insure that the pipe rests upon the bottom of the trench for its full length.

In the event that the bottom of the trench is in rock or is unsuitable material, the trench shall be excavated at a minimum of 6 inches {150 mm} below grade or as directed by the Engineer. The trench shall then be backfilled with crushed stone as specified in Section 853 or Engineer approved material up to the proper grade elevation.

All excavated material that is not suitable for use as backfill shall be removed from the project site or otherwise properly disposed.

The trench shall be dewatered to prevent standing or running water, and to allow for proper installation of the water pipe.

(c) Laying.

The laying of pipe in finished trenches shall be started at the outlet end and shall be installed up grade with the spigot end pointing in the direction of flow. The pipe shall be laid to the line and grade shown on the project plans. The pipe shall then be examined to make sure that it is free of defects. Pipe shall be fitted and matched to form a smooth, uniform invert. The pipe shall be installed in accordance with the pipe manufacturer's recommendations and as directed by the Engineer.

Pipes shall be lowered so as to avoid damage and unnecessary handling in the trench. The hubs and bells shall be clean when laid. The pipe shall be cleaned of debris and dirt when jointing the pipe. The ends of the pipes shall be securely closed when laying is stopped for the night to prevent animals and water from entering the pipe.

Water Mains shall have a minimum cover of 48 inches {1220 mm} under pavement and 36 inches {910 mm} under ditches. Reaction or thrust backing or other approved anchorage shall be provided on all mains 4 inches {100 mm} in diameter or larger at all wyes and tees, plugs, caps and at bends with a

deflection angle equal to or greater than 22.5 degrees. Concrete for thrust blocks shall be placed against undisturbed earth.

Walking and working on or over the completed water line, except as necessary for backfilling and tamping, shall not be permitted until at least 1 foot {0.3 m} of backfill is in place over the top of the pipe.

(d) Joints.

All joints shall be sealed for the entire circumference of the pipe providing an acceptable watertight joint.

The installation of rubber or other type gasket joints shall be in accordance with the pipe manufacturer's recommendations and as directed by the Engineer. No joint shall be finished until the two next joints in advance have been placed. Any joint that is disturbed after jointing shall be removed, cleaned, and remade.

Thermally fused joints shall be installed according to the pipe manufacturer's recommendations.

Where a restrained joint is required, locked mechanical joint retainer glands or restrained joint gaskets of adequate strength to prevent movement of the water main shall be used in addition to the concrete thrust block.

(e) Backfilling.

Backfilling shall be performed immediately after inspection as directed by the Engineer to secure the pipe position prior to proceeding to the next section.

The backfill material shall be carefully deposited equally on both sides of the pipe in uniform layers not to exceed 6 inches {150 mm} in compacted thickness to a density of not less than 95 percent of AASHTO T 99 maximum density. Backfill that is not under roadbeds shall be compacted as directed by the Engineer to be consistent with surrounding materials.

Where roadways and other crossings are disturbed, the Contractor shall restore them to their original condition and shall replace all surface material and all paving, sidewalks, sod, or other disturbed surfaces, by furnishing all necessary new materials without extra compensation.

All pipe shall be pressure tested as noted in this Section before complete backfilling of the pipe will be permitted.

All trenches and excavations shall be backfilled with approved natural soil unless shown otherwise on the plans.

After completing the backfill, the Contractor shall promptly remove all surplus material, rubbish, and all equipment, leaving the site and adjacent areas in a neat and presentable condition.

(f) Connection to Existing Water System.

Connection to the existing water system shall be made as shown on the plans and as directed by the Engineer. The connection shall be made to minimize interruption of service. The Contractor shall notify the Utility at least 24 hours prior to connecting to the existing system.

(g) Pressure Testing of Installed Lines.

1. General.

All lines installed under this Section shall be pressure tested as noted in this Subarticle and in accordance with AWWA C600. The Contractor shall have the option of testing the mains and service lines under one of the following conditions:

a. Lines uncovered.
b. Lines partially covered with joints and valves exposed.

The cost for this work shall be included in the unit price bid for installing the water pipe.

2. Testing.

a. Water Mains.

When a section of pipe is approved by the Engineer for testing, the Contractor shall furnish all materials, equipment, and labor to properly carry out the testing operation. This shall include, as a minimum, a test pump and a means of accurately measuring the volume of water necessary to maintain the required pressure during the prescribed time of testing. A recording pressure gauge shall be used during the pressure test and the charts shall be provided to the Engineer and the Utility. The Contractor shall furnish, install, and remove any temporary bulkheads, flanges, and plugs, as well as corporation stops at high points in the pipe line and at the test pump, when such are necessary for the testing operation.

Unless approved otherwise by the Engineer, all water mains, including corporation stops, shall be tested before service lines are installed. If, in the opinion of the Engineer, the high pressure

testing of the mains must be done after service lines are in place, the service lines shall be shut off at the corporation stops.

After necessary joints, corporation stops, bulkheads, etc. have been installed, temporary corporation stops, if no other means can be provided, shall be placed in the high points of the pipe line and at the pumps as required, to remove air from the water system.

The test pressure shall equal 150 percent of the working pressure, but not less than 100 psi {690 kPa} nor more than the pressure class of the pipe being tested. The minimum test period shall be six hours. However, the testing period shall be extended if the Engineer deems additional testing is necessary with no additional compensation given for the additional testing. The maximum leakage allowed shall be determined by the following formula:

$L = S\ D\ P^{1/2} / 133200$ {$L=S\ D\ P^{1/2} / 2816$}

L = allowable leakage in gallons/hour {liters/hour}
S = length of pipe tested in feet {meters}
P = test pressure in psig {bars}
D = nominal diameter of the pipe in inches{inches}

The Contractor shall provide suitable means for determining the quantity of water lost by leakage under the test pressure.

When, in the opinion of the Engineer, service lines cannot be shut off from the section to be tested or other conditions exist where pressure testing as described above may cause damage, the Engineer may approve that the line be tested under normal operating pressure.

The Contractor, at his expense, shall locate and repair defective joints, sections, or valves until the leakage is within the noted allowances. All observed leaks shall be repaired whether or not the leakage test results are within the requirements specified above. After the Contractor has made the necessary corrections, the main shall be retested as described above until the line passes the necessary requirements. All tests, and retests, shall be at the Contractor's expense.

b. Water Service Lines.

These lines shall be checked under normal operating pressures for at least six hours and the line completely inspected for visible leaks unless checked along with the mains as noted in the preceding Subitem a. The Contractor, at his expense, shall locate and repair or replace any connection or joint until leakage has been stopped.

(h) Sterilization.

Pipe lines and appurtenances, both existing and new, which are the responsibility of the Contractor by being within the overall limits of construction, shall be sterilized before being placed in service. The sterilization process shall be performed and accepted before all pressure tests have been performed to prevent contamination of the existing system.

The sterilization process shall, as a minimum, be that required by the governmental regulatory body having jurisdiction over the utility. The Contractor shall contact the utility owner or regulatory body to determine the acceptable sterilization treatment. The cost for this work shall be included in the unit price bid for the water pipe installation.

(i) Pigging.

When the water main is 12 inches {300 mm} in diameter or greater, the main shall be pigged and then flushed at the scouring velocity. The cost for this work shall be included in the unit price bid for the water pipe installation.

641.04 Method of Measurement.

(a) Water Main and Water Service Line.

The actual accepted length of water main and water service line laid or relaid will be measured in linear feet {meters} along the center of the line, complete in place. Tees, wyes, crosses, bends and fittings will not be deducted from the measurement for payment along the center of the line being laid.

(b) Fittings.

Ductile Iron Fittings will be measured by the fitting’s weight in pounds {kg}. Bolts and other miscellaneous items will not be included in the measured weights. Payment will be based on the manufacturer’s catalog weight of the supplied fitting. PVC and HDPE fittings, where allowed, will not be measured separately for payment.

(c) Fire and Flush Hydrants.

Fire and flush hydrants will be measured individually as one complete unit.

(d) Fire and Flush Hydrant Reset.

Fire and flush hydrant resets will be measured individually as one complete unit requiring removal and replacement.

(e) Fire Hydrant Extensions.

Fire hydrant extensions will be measured in vertical feet {meters} along the vertical center of the water line.

(f) Valve.

Valves and valve box where shown on the plans, will be measured individually as one complete unit of the valve including a valve stem extension where required.

(g) Concrete for Water Mains.

Concrete for water mains will be measured per cubic yard {cubic meter} installed for water main plugs, supports, anchors, and thrust blocks. Payment will be based on the actual quantity placed for the appropriate base and pipe size for normal soil conditions. Larger size blocks and payment based on larger concrete dimensions may be used when approved by the Engineer to accommodate poor soil conditions.

(h) Retainer Gland.

Retainer glands will be measured per each retainer gland required.

(i) Anchor Tee.

Anchor tees will be measured per each anchor tee required for fire hydrant installation.

(j) Tapping Valve and Sleeve.

Tapping valve and sleeves will be measured individually as one complete unit of the tapping valve and sleeve, valve stem extension where required, and valve box unit, including performing the tapping operation.

(k) Service Tap.

A service tap will be measured per each tap as a unit that includes the tapping sleeve, saddle, corporation and curb stops, and couplings.

(l) Water Meter and Box Set and Reset.

A water meter and box set and reset will be measured as the number of each set or reset as shown on the plans and shall include the water meter, meter box and cover, all connections and pipe necessary to set or to remove and reset the water meter and box.

(m) Valve Box Reset.

A valve box reset will be measured per each box reset and shall include the resetting of the valve box and cover.

(n) Line Stop.

A line stop will be measured per each line stop as a unit that includes installation and maintenance of the line stop and the thrust restraint, the removal of the line stop and installation of a blind flange.

641.05 Basis of Payment.

(a) Unit Price Coverage.

1. General.

Final acceptance of this work shall be subject to approval by the Utility Company involved. Therefore, payment for this work will not be made until the Contractor has obtained the Owner's written approval that the work performed complies with the local codes and requirements of the Utility Company.

2. Water Main.

The accepted quantity of water main laid or re-laid will be paid for at the contract unit price per linear foot {meter}, complete in place, which shall be payment in full for furnishing and installing pipe; including joint material, polyethylene sheathing when required, fittings for PVC and HDPE pipe, restrained joint when specified, making necessary pipe connections, pigging, flushing, testing, excavating, backfilling, backfill material, and for all other materials, tools, labor, equipment and incidentals necessary to complete the work.

3. Water Service Line.

The accepted quantity of water service line laid or re-laid will be paid for at the contract unit price per linear foot {meter}, complete in place, which shall be payment in full for furnishing and installing pipe; fittings for PVC pipe only, couplings, and joint material, excavating, backfilling, backfill material and for all other materials, tools, labor, equipment and incidentals necessary to complete the work.

4. Fittings.

Ductile iron fittings will be paid for at the contract unit price for each pound {kg} of fittings specified on the project plans which shall be payment in full for all labor, materials, equipment and incidentals necessary to furnish and install the size fitting required.

5. Fire and Flush Hydrant.

Fire and flush hydrants will be paid for at the contract unit price and include all labor, materials, equipment and incidentals necessary to furnish and install one hydrant. Fire hydrants shall also include 3 feet {1 m} of piping to connect to the water line. Additional piping to connect to depths greater than 3 feet {1 m} will be paid as fire hydrant extension.

6. Fire and Flush Hydrant Reset.

Fire and flush hydrant resets will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to reset one hydrant complete in place including excavation, backfilling, resetting the fire hydrant and all necessary connections, valves, and pipe. If any new fire hydrant extensions are required, they will be paid for under the appropriate pay item.

7. Fire Hydrant Extensions.

Fire hydrant extensions will be paid for at the contract unit price per linear foot {meter} which shall be payment for all labor, materials, equipment and incidentals necessary to extend one fire hydrant unit to the required water line grade.

8. Valve.

Valves will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one valve, valve stem extension where required, and valve box as appropriate for the type of valve being installed.

9. Concrete for Water Mains.

Concrete for water mains will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and place the concrete.

10. Retainer Gland.

Retainer glands will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one retainer gland. Retainer Glands may be used in lieu of restrained joint pipe upon which payment will be for restrained joint pipe, not Retainer Glands.

11. Anchor Tee.

Anchor tees will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one anchor tee.

12. Tapping Valve and Sleeve.

A tapping valve and sleeve for extending water service availability will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one assembly of tapping valve and sleeve, valve stem extension where required, and valve box.

13. Service Tap.

A service tap for providing water to a user will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one service tap including the tapping sleeve, saddle, corporation and curb stops, and couplings.

14. Water Meter and Box Set and Reset.

Water meter and box set and reset will be paid for at the respective contract price which shall include all labor, materials, equipment and incidentals necessary to set or to remove and reset a water meter and box complete in place.

15. Valve Box Reset.

Valve box reset will be paid for at the respective contract price which shall include all labor, materials, equipment and incidentals necessary to reset the box complete in place.

16. Line Stop.

A line stop for stopping the flow of water in a portion of the main without interruption of water service will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to install an utility approved line stop, install the adequate thrust restraint, maintenance of the line stop during construction, removal of the line stop and the installation of a blind flange at the bypass outlet upon completion of the water main construction.

(b) Payment shall be made under Item No.:

641-A ___ inch {mm} _*_ Water _**_ Laid _(***)_ - per linear foot {meter}
641-B ___ inch {mm} _*_ Water _**_ Relaid _(***)_ - per linear foot {meter}
641-C Ductile Iron Fittings – per pound {kg}
641-D Fire Hydrant – per each
641-E Fire Hydrant Reset – per each
641-F Fire Hydrant Extension – per linear foot {meter}
641-G Flush Hydrant – per each
641-H Flush Hydrant Reset – per each
641-I ___ inch {mm} Air Release Valve – per each
641-J ___ inch {mm} Gate Valve with Box – per each
641-K ___ inch {mm} Butterfly Valve with Box – per each
641-L Concrete for Water Mains (Thrust Blocks) – per cubic yard {cubic meter}
641-M ___ inch {mm} Retainer Gland – per each
641-N ___ inch {mm} x ___ inch {mm} Anchor Tee – per each
641-O ___ inch {mm} x ___ inch{mm} Tapping Valve and Sleeve – per each
641-P ___ inch {mm} Service Tap – per each
641-Q ___ inch {mm} Water Meter and Box Set – per each
641-R ___ inch {mm} Water Meter and Box Reset – per each
641-S Valve Box Reset - per each
641-T ___inch{mm} Line Stop – per each

* Show Type of Pipe: Ductile Iron (DI); PolyVinyl Chloride (PVC); Polyethylene (PE); High Density Polyethylene (HDPE); Crosslinked Polyethylene (PEX Type A); Copper.
** Designate One Type: Main or Service Line.
*** Designate Restrained Joint if Required.

SECTION 645
SANITARY SEWERS

645.01 Description.

This Section shall cover the work of the following:

- furnishing and installing new sanitary sewers, force mains, and manholes
- removing, replacing, and resetting existing sanitary sewers, force mains, and manholes
- constructing connections to existing sewers and manholes

All work performed and materials used shall be in accordance with ALDOT plans and specifications and the Utility's requirements. In the event that there is a conflict between the ALDOT specifications and the Utility's requirements, the more stringent requirement shall govern.

645.02 Materials.

Materials furnished for use shall conform to the requirements of Section 853 and other appropriate Sections of Division 800, Materials.

The pipe strength shall be in accordance with the requirements of Section 853 unless otherwise noted by the project plans or determined by the actual laying conditions.

Concrete used for construction of sanitary sewers, force main, and manholes shall be Class A concrete in accordance with the requirements given in Section 501.

645.03 Construction Requirements.

(a) General.

1. Sanitary Sewer.

Pipe shall be laid in the presence of the Inspector, and shall not be covered until allowed by the Project Manager. Pipe that is damaged or deemed unfit for use by the Department due to negligence, improper handling, or improper installation shall be replaced by the Contractor without additional compensation.

All new pipes shall be handled in such a manner as to prevent damage to the pipe and pipe lining. The interior of all pipes shall be free from dirt and debris. All material shall be stored in the appropriate manner to protect the materials from damage by freezing and subsequent handling.

The construction methods employed in the adjustment, relocation, and placement of the sewer lines shall be in accordance with the current codes and practices of the Utility Company involved.

Work required for the adjustments of sewer mains, fittings, and service lines shall be performed by the Contractor in such a manner that shall limit interruption of the service for a minimum period of time. Notice shall be made by the Contractor to the Customers affected by the service interruption at least four hours but not more than 72 hours prior to service interruption.

When installing non-metallic sewer force main pipe, the Contractor shall install a metallic tape on the pipe or provide other suitable means to allow for location by electronic detection devices.

When ductile iron sewer pipe and fittings are located in potentially corrosive soil conditions, the pipe shall be wrapped in polyethylene sheath meeting AWWA C105.

Air and vacuum valve assemblies shall be installed in the force main to allow for the release of potentially trapped air along elevation changes in the force main as show on the plans. The air and vacuum valve assembly shall be as detailed in the project plans and specifications.

When abandoning an existing sanitary sewer, the sanitary sewer shall be cut, filled with cement mortar flowable backfill (Section 260, Mix 4), and the ends shall be capped.

2. Manhole.

Pre-cast concrete manholes shall be constructed in accordance with AASHTO M 199. Manholes shall be smooth and free from fractures, chips, and honeycombs. Care shall be taken not to damage the manhole sections during handling and installation. The manhole shall be constructed to minimize the number of manhole joints.

The invert and bottom curves of all manholes shall be neatly and accurately built and formed to facilitate the entrance and flow of sewage over them.

When required, a branch pipe consisting of one segment of ductile iron pipe of the required size shall be built into manholes to receive either present or future branch lines. Branch lines for future flows shall have an Engineer approved mechanical plug.

New manholes shall be supplied with Engineer approved cast-in or cored flexible manhole pipe connectors (boots) for each pipe cutout. The flexible manhole pipe connector (boot) shall meet the requirements of ASTM C 923. The connector shall be installed in the manhole wall in accordance with the manufacturer’s recommendations.

Existing manholes cored for connection of sewer pipe shall be fitted with Engineer approved flexible manhole pipe connectors (boots). The flexible manhole pipe connector (boot) shall meet ASTM C 923 requirements. The connector shall be installed in the manhole wall in accordance with the manufacturer’s recommendations.

All manhole pipe connectors (boots) shall be sized specifically for the pipe material, pipe size, and manhole size being used.

Joints in riser and cone sections shall have a rubber gasket or an approved equal meeting the requirements of ASTM C 443.

Manholes shall be provided with steps, inflow dishes, chimney seals, and linings as required by the project plans and specifications.

3. Abandon Existing Manhole.

Abandoning an existing manholes shall include breaking the manhole off to a depth of three feet below grade, creating holes for drainage in the bottom, furnishing, placing and

compacting sand or sand-clay backfill to the original grade, removing and cleaning the frame and cover, and transporting the frame and cover to the Utility.

4. Resetting Manhole Cone-Shaped Top Section (Cone).

Manholes requiring the cone section to be removed and replaced to lower or raise the manhole top elevation more than two feet, to allow for the addition/removal of a manhole unit section, without moving the structure location shall be considered a manhole cone reset. All work shall be done in a workman like manner by competent workmen and the manhole structure re-established in proper working order at its new elevation. Any manhole material broken, destroyed, lost, or rendered unfit for reuse through carelessness, negligence, or improper handling of the work, shall be replaced by the Contractor without extra compensation.

When adjustments to manholes require the removal of a portion of the existing manhole, the Engineer shall designate that portion of the structure to be removed. The removal cost shall be included in the unit price bid for the manhole cone reset.

When required to reach the elevation shown on the project plans, the manhole frame and cover shall be raised or lowered using brick and mortar, concrete "donut" rings, cast iron riser ring, or Engineer approved equal.

The resetting of an existing manhole cone section shall be in conjunction with installation of manhole unit sections.

5. Resetting Manhole Frame and Cover.

Manhole frame and covers that are raised or lowered in top elevation less than 2 feet {600 mm} without removing the manhole cone or moving the structure location shall be considered reset. All work shall be done in a workmanlike manner by competent workmen and the unit re-established in proper working order at its new elevation. Any material broken, destroyed, lost, or rendered unfit for reuse through carelessness, negligence, or improper handling of the work, shall be replaced by the Contractor without extra compensation. Concrete and brick masonry work shall conform to requirements of Sections 620 and 613, respectively. The Manhole frame and cover shall be raised or lowered using brick and mortar, concrete “donut” rings, cast iron riser ring, or Department approved equal.

6. Manhole Drop Connection.

Where required on the plans, a drop connection shall be constructed at manholes as detailed in the project plans and specifications. Piping for drop connections shall be ductile iron except where noted otherwise on the Plans.

(b) Excavation and Foundation.

The trench shall be excavated true to established lines and grades as shown on the project plans. Tunneling will not be permitted unless authorized in writing. Trenches shall be excavated at least 9 inches {230 mm} on each side of the pipe. Trenches shall be properly sheeted or braced wherever needed to prevent cave-in or loose soil from falling into the trench. Sides of the trenches shall be kept as near vertical as possible. Bell holes shall be excavated to insure that the pipe rests upon the bottom of the trench for its full length.

In the event that the bottom of the trench is in rock or is unsuitable material, the trench shall be excavated at a minimum of 6 inches {150 mm} below grade or as directed by the Engineer. The trench shall then be backfilled with crushed stone as specified in Section 853 up to the proper grade elevation.

All excavated material that is not suitable for use as backfill shall be removed from the project site or otherwise satisfactorily disposed.

The trench shall be dewatered to prevent standing or running water, and to allow for proper installation of the sewer.

(c) Laying.

The laying of pipe in finished trenches shall be started at the outlet end and shall be installed up grade with the spigot end pointing in the direction of flow. The pipe shall be laid to the line and grade shown on the project plans. The pipe shall then be examined to make sure that it is free of defects. Pipe shall be fitted and matched to form a sewer with a smooth, uniform invert. The pipe shall be installed in accordance with the pipe manufacturer’s recommendations and as directed by the Engineer.

Pipes shall be lowered so as to avoid damage and unnecessary handling in the trench. The hubs and bells shall be clean when laid. The pipe shall be cleaned of debris and dirt when jointing the

pipe. The end of the pipes shall be securely closed when laying is stopped for the night to prevent animals and water from entering the pipe.

Wyes or tees shall be installed along with lateral sewer pipe where designated on the project plans to connect existing or future services. When laterals are required on the plans or instructed by the Engineer, the lateral shall extend to the right-of-way line or as directed by the Engineer. When the lateral is not connected to an existing lateral, the end shall be plugged as specified by the Engineer.

Force Mains shall have a minimum cover of 36 inches {910 mm} and 48 inches {1.220 m} when under pavement. Concrete thrust blocks shall be placed along the force main at vertical and horizontal bends and fittings. The thrust block shall be poured against undisturbed earth.

Walking and working on or over the completed sewer line, except as necessary for backfilling and tamping, will not be permitted until at least 1 foot {0.3 m} of backfill is in place over the top of the pipe.

Air and vacuum valves for force mains shall be placed along the force main as required by the project plans.

(d) Joints.

All joints shall be sealed for the entire circumference of the pipe providing an acceptable watertight joint.

The installation of rubber or other type gasket joints shall be in accordance with manufacturer's recommendations and as directed by the Engineer. No joint shall be finished until the two next joints in advance have been placed. Any joint that is disturbed after jointing shall be removed, cleaned, and reinstalled.

Thermally fused joints shall be installed according to the pipe manufacturer’s recommendations.

Where a restrained joint is required on the project plans, locked mechanical joint retainer glands or restrained joint gaskets of adequate strength to prevent movement of the force main shall be used in addition to the concrete thrust block. Retainer glands shall be the type shown on the plans or designated by the Engineer and shall be installed in accordance with the Utility Company requirements.

(e) Backfilling.

Backfilling shall be performed immediately after inspection as directed by the Engineer to secure the pipe position prior to proceeding to the next section.

All trenches and excavations shall be backfilled with approved natural soil or, when directed by the Engineer, with foundation backfill material.

The backfill material shall be carefully deposited equally on both sides of the pipe in uniform layers not to exceed 6 inches {150 mm} in compacted thickness to a density of not less than 95 percent of AASHTO T99 maximum density. Backfill that is not under roadbeds shall be compacted as directed by the Engineer to be consistent with surrounding materials.

Where roadways and other crossings are disturbed by placing the sewer, the Contractor shall restore them to their original condition and shall replace all surface material and all paving, sidewalks, sod, or other disturbed surfaces, furnishing all necessary new materials without extra compensation except as provided in this section. Topsoil disturbed by excavation across private property shall be replaced as nearly as possible to its original position.

After completing the backfill, the Contractor shall promptly remove all surplus material, rubbish, and all equipment, leaving the site and adjacent areas in a neat and presentable condition.

(f) Connection to Existing Sewer System.

Connection to existing sewer shall be made as shown on the plans and as directed by the Engineer. Connection shall be made to minimize interruption of service. Where required to allow for continuous service, bypass pumping shall be performed and shall be incidental to the installation of the sanitary sewer.

Connection to an existing manhole shall be made by coring the manhole wall and installing a Engineer approved manhole pipe connector (boot). The void space around the boot and manhole shall be filled with non-shrinking grout.

Connection of dissimilar type pipes shall be made with a coupler or adapter as approved by the Engineer.

(g) Testing.

After completion of the installation of the sanitary sewer, all lines shall be tested. All lines shall be cleaned of dirt and debris prior to testing. Debris and dirt shall be removed from the sewer system and not flushed to the next segment of sewer.

The sanitary sewer and force main shall be either air tested or hydrostatic tested as required by the Engineer.

All manholes shall be tested as required by the project plans and specifications. Testing of manholes and structures shall be performed after curing of linings. Any leakage in the manhole or structure, before, during, or after the test shall be repaired by the contractor for no additional compensation.

645.04 Method of Measurement.

(a) Sewer Pipe.

The actual accepted length of sanitary sewer and force main laid or re-laid will be measured in linear feet {meters} along the center of the line, complete in place.

(b) Fittings.

Ductile iron fittings will be measured by the fitting's weight in pounds {kg}. Bolts and other miscellaneous items will not be included in the weights. Payment will be based on the manufacturer's catalog weight of the supplied fitting.

(c) Stacks and Laterals.

The actual accepted length of service stacks and laterals will be measured in linear feet {meters} along the center of the line, complete in place.

(d) Abandon Existing Sanitary Sewer.

The abandonment of an existing sanitary sewer will measured per linear foot of sanitary sewer abandoned.

(e) Sanitary Sewer Lateral Cleanout.

A sanitary sewer lateral cleanout will be measured per each complete cleanout required.

(f) Retainer Gland.

Retainer glands will be measured per each retainer gland required.

(g) Manhole.

Manholes will be measured per each as individual units including footing, bottom slab, bench, wall sections, cone, casting, and manhole cover. Manholes shall also include steps, lining, chimney seal, and inflow dish as shown to be required on the plans. The maximum height of the measurement of a manhole for payment will be 6 feet {2 m}. This will be measured from the top of the bottom slab to the top of the cover. The additional height of a manhole above 6 feet {2 m} that is required for raising or lowering a manhole will be measured in manhole units.

(h) Manhole Unit.

Manhole wall sections required to raise or lower an existing manhole, or lower a new manhole, will be measured per each manhole unit. The manhole unit will be in increments of 2 feet {610 mm} and shall match the structure being raised or lowered. Required increments that are less than 2 feet {610 mm} will be measured as a complete manhole unit.

(i) Manhole Cone Reset.

Manhole cone reset will be measured per each as one complete unit of the manhole cone shaped top section and manhole frame and cover requiring removal and replacement when raising or lowering the elevation of an existing manhole.

(j) Manhole Frame and Cover Reset.

Manhole frame and cover reset will be measured per each as one complete unit of the manhole frame and cover requiring removal and replacement when raising or lowering and existing manhole without the addition or removal of manhole units (less than two feet {610 mm}).

(k) Connection to Existing Manhole.

Connection to existing manhole will be measured per each connection.

(l) Abandon Existing Manhole.

The abandonment of an existing manhole will measured per each manhole abandoned.

(m) Manhole Drop Connection.

Manhole drop connection will be measured per vertical foot {meter} of drop from entrance of the sewer pipe to the invert of the manhole including tee, bends, fittings, and pipe.

(n) Air and Vacuum Valve Assembly.

An air and vacuum valve assembly will be measured per each complete assembly as detailed in the project plans and specifications.

(o) Sanitary Sewer Lift Station.

A sanitary sewer lift station will be measured per each complete lift station.

645.05 Basis of Payment.

(a) Unit Price Coverage.

1. General.

Final acceptance of this work shall be subject to approval by the Utility Company involved, therefore, the Engineer may withhold payment for this work until the Contractor has obtained the Utility's written approval that the work performed complies with the local codes and requirements of the Utility Company.

2. Sewer Pipe.

The accepted length of sanitary sewer and force main laid or re-laid will be paid for at the respective contract unit prices for the types and sizes specified in the proposal including the excavation and backfilling which shall be payment in full for furnishing, hauling, excavating, foundation preparation, laying or relaying, backfilling, compacting, cleaning up, and for all materials, equipment, tools, labor, and incidentals necessary to complete the work except manholes, junction boxes, or like connecting masonry. Sanitary sewer pipe being re-laid shall mean removing and reusing the existing sewer pipe.

The contract unit price shall be for an embedment depth of 6 feet {1.8 m} or less below the existing ground line. The length of sanitary sewer pipe laid or re-laid, measured as provided above, at depths greater than 6 feet {1.8 m} below the existing ground line shall have an adjusted unit price, arrived at by increasing the contract unit price by the percentage indicated in the table below.

Depth Sewer Installed Below Existing Ground Line	Percentage Contract Unit Price Bid to be Increased
More than 6 feet {1.8 m}, but less than 10 feet {3 m}	25%
10 feet {3 m} and more, but less than 12 feet {3.7 m}	50%
12 feet {3.7 m} and more, but less than 16 feet {4.9 m}	75%
16 feet {4.9 m} and more	100%

3. Fittings.

Ductile iron fittings will be paid for at the contract unit price for each pound {kilogram} of fitting specified on the project plans which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install the size fitting required.

4. Stacks and Laterals.

Stacks and laterals will be paid for at the contract unit price for the types and sizes specified in the proposal and shall include all labor, materials, equipment, and incidentals necessary to extend the lateral from the main to the right-of-way or easement line. The unit price shall also include pipe, fittings, plugs, caps, backfilling, compacting, hauling and excavating.

5. Abandon Existing Sanitary Sewer.

The abandonment of an existing sanitary sewer will be paid for at the contract unit price for the sizes specified in the proposal which shall be payment in full for furnishing all labor material, equipment, tools, and incidentals necessary, including flow able backfill and end caps to abandon an existing sanitary sewer.

6. Sanitary Sewer Lateral Cleanout.

A sanitary sewer lateral cleanout will be paid for at the contract unit price for the size specified in the proposal which shall be payment in full for furnishing all labor material, equipment, tools, and incidentals necessary including single or double sweep tee, pipe, recessed nut cap, traffic loading cap when required, for a complete sanitary sewer cleanout.

7. Retainer Gland.

Retainer glands will be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one retainer gland. Retainer Glands may be used in lieu of restrained joint pipe upon which payment will be made for restrained joint pipe, not retainer glands.

8. Manhole.

A manhole will be paid for at the contract unit price for the sizes specified in the proposal which shall be payment in full for furnishing, hauling, excavating, backfilling, compacting, cleaning up, and for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

9. Manhole Unit.

A manhole unit will be paid for at the contract unit price for the sizes specified in the proposal which shall be payment in full for furnishing, hauling, excavating, foundation preparation, backfilling, compacting, cleaning up, and for all materials, equipment, tools, labor, and incidentals necessary to complete the work. The removal and replacement of the manhole cone and frame and cover will be paid for under Manhole Cone Reset.

10. MANHOLE CONE SHAPED TOP SECTION (CONE) RESET.

A manhole cone reset, measured as noted above will be paid for at the contract unit price for Manhole Cone Reset, which shall be payment in full for all material, equipment, tools, labor, and incidentals necessary to complete the work herein specified. The unit price shall include the removal and reinstalling of the existing manhole cone section and manhole frame and cover.

11. MANHOLE FRAME AND COVER RESET.

A manhole frame and cover reset will be paid for at the contract unit price for Manhole Frame and Cover Reset, which shall be payment in full for all material, equipment, tools, labor, and incidentals necessary to complete the work.

12. CONNECTION TO EXISTING MANHOLE.

Connection to existing manhole will be paid for at the contract unit price which shall be payment in full for a manhole pipe connector (boot), all labor material, equipment, tools, and incidentals necessary to connect the new sanitary sewer pipe to an existing manhole.

13. ABANDON EXISTING MANHOLE.

Abandon existing manhole will be paid for at the contract unit price which shall be payment in full for all labor material, equipment, tools, and incidentals necessary including backfill to abandon an existing manhole.

14. MANHOLE DROP CONNECTION.

A manhole drop connection, measured as noted above will be paid for at the contact unit price for the type specified , which shall be payment in full for all pipe, tees, wyes, cleanout stack, materials, equipment, tools, labor, and incidentals necessary to complete the work.

15. AIR AND VACUUM VALVE ASSEMBLY.

An air and vacuum valve assembly will be paid for at the contract unit price for the size specified in the proposal which shall be payment in full for all labor, materials, equipment and incidentals necessary to furnish and install one air and vacuum valve assembly which shall include the box/manhole containing the valve.

16. SANITARY SEWER LIFT STATION.

A sanitary sewer lift station will be paid for at the contract unit price for each lift station specified in the proposal which shall be payment in full for all labor, materials, equipment and incidentals necessary to furnish and install one lift station. This shall include all items within the lift station limits shown on the plans including all piping, valves, valve boxes, pumps, wet well, buildings, fencing, grading, and site access when required.

(b) Payment Will Be Made Under Item No.:

645-A ___ inch {mm} __*__ Sanitary Sewer __**__ Pipe Laid (***) - per linear foot {meter}
645-B ___ inch {mm} __*__ Sanitary Sewer __**__ Pipe Relaid (***) - per linear foot {meter}
645-C Ductile Iron Fittings – per pound {kg}
645-D ___ inch {mm} Retainer Gland – per each
645-E ___ inch {mm} __****__ Stacks and Laterals – per linear foot {meter}

645-F Abandon __ inch {mm} Existing Sanitary Sewer – per linear foot {meter}
645-G ___ inch {mm} Sanitary Sewer Lateral Cleanout – per each
645-H ___ inch {mm} Manhole - per each
645-I ___ inch {mm} Manhole Unit - per each
645-J Manhole Cone Reset – per each
645-K Manhole Frame and Cover Reset – per each
645-L ___ inch {mm} ____ Manhole Drop Connection – per linear foot {meter}
645-M Connection to Existing Manhole – per each
645-N Abandon Existing Manhole – per each
645-O ___ inch {mm} Air and Vacuum Valve Assembly – per each
645-P Sanitary Sewer Lift Station – per each
* Show Type of Pipe: Ductile Iron (DI), Polyvinyl Chloride (PVC), High Density Polyethylene (HDPE), High Performance Polypropylene (PP)
** Designate One Type: Gravity or Force Main
*** Designate Restrained Joint if Required
**** Show Type: Ductile Iron (DI); Polyvinyl Chloride (PVC)

SECTION 646
NATURAL GAS LINE

646.01 Description.

This Section shall cover the work of the following

- Furnishing and installing new gas mains and valves;
- Removing, relaying, and resetting existing gas mains and valves;
- Constructing connections to existing gas mains.

646.02 Materials.

Materials furnished for use shall conform to the requirements of Section 861 and other appropriate Sections of Division 800, Materials.

646.03 Construction Requirements.

(a) General.

1. Gas Pipe.

Pipe shall be laid or relaid in the presence of the Engineer. Pipe shall not be covered until allowed by the Engineer. Pipe designated to be relaid that is damaged or rendered unfit for use through negligence or improper handling shall be replaced by the Contractor without additional compensation.

All new pipes shall be handled in such a manner as to prevent damage to the pipe and pipe lining. The interior of all pipes, valves, and fittings shall be free from dirt and debris. All material shall be stored in the appropriate manner to protect the materials from damage by freezing and subsequent handling.

The construction methods employed in the adjustment, relocation, and placement of the gas lines shall be in accordance with the current codes and practices of the Utility Company involved. The work shall conform to the applicable requirements of the US Department of Transportation, Transportation of Natural and other Gas by Pipelines, Minimum Safety Standards. Notification to the line locators to locate the other utilities in the construction area shall be made at least 48 hours prior to performing work.

Work required for the adjustments of a gas main and service line shall be performed by the Contractor in such a manner that shall limit interruption of the service for a minimum period of time. Notice shall be made by the Contractor to the Customers affected by the service interruption at least four hours but not more than 72 hours prior to service interruption.

When installing non-metallic gas pipe, the Contractor shall install a detectable tape or locating wire on the pipe or provide other suitable means approved by the Engineer to allow for location by electronic detection devices.

Valves and other controls on the existing gas system shall not be operated for any purpose by the Contractor without approval and representation by the Utility.

Welding of steel pipe shall be in accordance with ASME B31.8 or API 1104. Each welder shall be certified for the type work specified. Certificates of welders performing the work shall be furnished to the Engineer prior to beginning the work. Test pieces cut from the work being performed shall be provided to the Engineer when required.

Each section of the gas distribution system shall be thoroughly cleaned with compressed air to remove all dirt and foreign matter. Taps shall be provided at all remote points. Once all lines have been completely and thoroughly purged, the taps shall be tightly sealed with steel plugs or by welding.

Cathodic protection shall be provided as described in the project plans and specifications.

2. Valves.

All valves shall close when the nut is turned clockwise. All valves shall have a non-rising stem and extension matching the valve stem to the finished grade. All valves shall be plumb and shall be set and jointed to the new pipe as specified for laying pipe. Valve flanges shall be as specified for fittings.

Valve boxes shall be plumb and centered over the wrench nut of the valve with the box cover flush with the finished pavement or unpaved area.

Valve boxes subject to traffic loading shall be set on brick or concrete to prevent box from bearing against the valve or piping.

The word Gas shall be cast into the cover of the valve box.

3. Valve Box Reset

A valve box shall not be reset until approved by the Engineer. The box shall be adjusted carefully to make sure that the top is at the designated location and elevation. Backfill shall be tamped around each box located in the pavement area to the required density of the adjacent material. Any box or accessories lost or rendered unfit for re-use due to negligence or improper handling by the Contractor shall be replaced in kind without additional compensation.

4. Line Stoppers.

All line stoppers shall be installed at the locations designated to retain the contents of existing pipe outside the construction area along with preventing contamination of the existing pipeline system. Line stopper equipment shall be installed as a manufactured package unit and pressure rated to safely cease the flow of the contents of the existing main. The line stopper procedure shall be performed by those specialized in those operations. Line stopper equipment shall be manufactured and operated by T. D. Williamson Inc., Mueller Co. or Engineer approved equal. Vendors shall have a minimum of 10 years of successful experience in the line stopper industry.

All equipment shall meet the pressure rating for the line to be tapped.

(b) Excavation and Foundation.

The trench shall be excavated to the designated line and grade when required. The trench width shall be sufficient to permit work on the pipe and inspection of the work. Mains shall have a minimum trench width of 18 inches {460 mm} plus the outside diameter of the pipe with the depth sufficient to provide for foundation preparation and proper cover unless stated otherwise on the project plans. Trenches shall be properly sheeted or braced wherever needed to prevent cave-in or loose soil from falling into the trench. Sides of the trenches shall be kept as near vertical as possible. The trench shall be excavated to insure that the pipe rests upon the bottom of the trench for its full length.

In the event that the bottom of the trench is in rock or is unsuitable material, the trench shall be excavated at a minimum of 6 inches {150 mm} below grade or as directed by the Engineer. The trench shall then be backfilled with crushed stone as specified in Section 853 or Engineer approved material up to the proper grade elevation.

All excavated material that is not suitable for use as backfill shall be removed from the project site or otherwise properly disposed.

The trench shall be dewatered to prevent standing or running water, and to allow for proper installation of the gas pipe.

(c) Laying.

The laying of pipe in finished trenches shall be started at the outlet end and shall be installed up grade. The pipe shall be laid to the line and grade shown on the project plans. The pipe shall then be examined to make sure that it is free of defects. Pipe shall be fitted and matched to form a smooth, uniform invert. The pipe shall be installed in accordance with the pipe manufacturer's recommendations and as directed by the Engineer.

Pipes shall be lowered so as to avoid damage and unnecessary handling in the trench. The pipe shall be cleaned of debris and dirt when jointing the pipe. The ends of the pipes shall be securely closed when laying is stopped for the night to prevent animals and water from entering the pipe.

Gas Mains shall have a minimum cover of 36 inches {910 mm} under ditches and 48 inches {1220 mm} under pavement unless stated otherwise on the project plans.

Walking and working on or over the completed gas line, except as necessary for backfilling and tamping, shall not be permitted until at least 1 foot {300 mm} of backfill is in place over the top of the pipe.

(d) Joints and Fittings.

All steel pipe joints and fittings shall be welded. Fittings shall be in accordance with ANSI B 16.5 or ANSI B16.9. All joints shall be sealed for the entire circumference of the pipe providing a watertight joint.

All polyethylene joints shall be welded as required by the Manufacturer’s requirements.

(e) Backfilling.

Backfilling shall be performed immediately after inspection as directed by the Engineer to secure the pipe position prior to proceeding to the next section. The backfill material shall be carefully deposited equally on both sides of the pipe in uniform layers not to exceed 6 inches {152 mm} in compacted thickness to a density of not less than 95 percent of AASHTO T 99 maximum density. Backfill that is not under roadbeds shall be compacted as directed by the Engineer to be consistent with surrounding materials. Where roadways and other crossings are disturbed, the Contractor shall restore them to their original condition and shall replace all surface material and all paving, sidewalks, sod, or other disturbed surfaces, by furnishing all necessary new materials without extra compensation.

All pipe shall be tested as noted in this Section, or the method prescribed by the Engineer, whichever is the more stringent, before complete backfilling of the pipe shall be permitted.

All trenches and excavations shall be backfilled with approved natural soil or, when directed by the Engineer, with select foundation backfill material.

After completing the backfill, the Contractor shall promptly remove all surplus material, rubbish, and all equipment, leaving the site and adjacent areas in a neat and presentable condition.

(f) Connection to Existing Gas System.

Connection to the existing gas system shall be made as shown on the plans and as directed by the Engineer and designated as "hot tap". The connection shall be made to minimize interruption of service. The Contractor shall notify the Utility at least 24 hours prior to connecting to the existing system. Service connections shall be made to the top or side of the main and shall be graded as to drain into the main unless otherwise noted on the plans.

(g) Air Pressure Testing of Installed Lines.

1. Mains.

When a section of pipe is approved by the Engineer for testing, the Contractor shall furnish all materials, equipment, and labor to properly carry out the testing operation. A recording pressure gauge shall be used during the pressure test and the charts shall be provided by the Contractor to the Utility. The Contractor shall furnish, install, and remove any temporary bulkheads, flanges, and plugs when such are necessary for the testing operation.

Unless approved otherwise by the Engineer, all gas mains shall be tested before service lines are installed.

The pipe shall be air pressured to 1 1/2 times the maximum allowed operating pressure (MAOP) for the system. The pipe shall hold the air pressure for 24 hours.

The Contractor, at his expense, shall locate and repair defective joints, sections, or valves until the leakage is eliminated. All observed leaks shall be repaired. After the Contractor has made the necessary corrections, the main shall be retested as described above until the line passes the necessary requirements. All tests, and retests, shall be at the Contractor's expense.

2. Service Lines.

Service line testing shall be as noted for mains except for the pressure which must be held for 60 minutes.

(h) Holiday Detector Test.

Immediately prior to lowering the pipe into the trench, the pipe shall be tested by an Engineer approved holiday detector.

The Contractor, at his expense, shall locate and repair defective joints, sections, or valves. After the Contractor has made the necessary corrections, the main shall be retested as described above until the line passes the necessary requirements. All tests, and retests, shall be at the Contractor's expense.

646.04 Method of Measurement.

(a) Gas Main and Gas Service Line.

The actual accepted length of gas main and gas service line laid or relaid shall be measured in linear feet {meters} along the center of the line, complete in place. Tees, wyes, crosses, bends and fittings shall not be deducted from the measurement for payment along the center of the line being laid.

(b) Fittings.

Fittings shall be measured individually per each fitting including bolts and gaskets as needed.

(c) Valves.

Valves shall be measured per each individually as one complete unit including a valve stem extension, where required, and a valve box.

(d) Hot Tap.

Hot taps shall be measured individually per each hot tap performed for the various sizes and types and shall include the tapping tee and saddle when necessary to perform the hot tap.

(e) Valve with Box Reset

A valve with box reset will be measured per each box reset and shall include the valve and the resetting of the valve box and cover.

(f) Gas Valve Box Reset

A valve box reset will be measured per each box reset and shall include the resetting of the valve box and cover.

(g) Line Stoppers.

Line Stoppers shall be measured per each individually as one complete unit including installation, maintenance and removal as necessary to complete the operation.

646.05 Basis of Payment.

(a) Unit Price Coverage.

1. General.

Final acceptance of this work shall be subject to approval by the Utility Company involved. Therefore, payment for this work shall not be made until the Contractor has obtained the Utility's written approval that the work performed complies with the local codes and requirements of the Utility Company.

2. Gas Main.

The accepted quantity of gas main laid or re-laid shall be paid for at the contract unit price per linear foot {meter}, complete in place, which shall be payment in full for furnishing and installing pipe; including joint material, making necessary pipe connections, pipe line markers, testing, excavating, backfilling, and for all materials, tools, labor, equipment and incidentals necessary to complete the work.

3. Gas Service Line.

The accepted quantity of gas service line laid or re-laid shall be paid for at the contract unit price per linear foot {meter}, complete in place, which shall be payment in full for furnishing and installing pipe; and joint material, excavating, backfilling, and for all materials, tools, labor, equipment and incidentals necessary to complete the work.

4. Fittings.

Fittings shall be paid for at the contract unit price for each fitting specified on the project plans and includes all labor, materials, equipment and incidentals necessary to furnish and install the size fitting required.

5. Valve.

Valves shall be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one valve, valve stem extension, where required, and valve box.

6. Hot Tap.

A hot tap shall be paid for at the contract unit price which shall be payment for all labor, materials, equipment and incidentals necessary to furnish and install one hot tap including tapping valve.

7. Valve with Box Reset

Valve with box reset will be paid for at the respective contract price which shall include all labor, materials, equipment and incidentals necessary to furnish and install the valve and to reset the box complete in place.

8. Gas Valve Box Reset

Valve box reset will be paid for at the respective contract price which shall include all labor, materials, equipment and incidentals necessary to reset the box complete in place.

9. Line Stoppers.

Line Stoppers shall be paid for at the contract unit price for each line stopper complete in place, which shall be payment for furnishing and installation of the line stopper including all materials, tools, labor, equipment, excavation, backfilling and incidentals necessary to complete the work.

(b) Payment shall be made under Item No.:

646-A ___ inch {mm} __* Gas __** Laid - per linear foot {meter}
646-B ___ inch {mm} __* Gas __** Relaid - per linear foot {meter}
646-C ___ inch __* Fittings – per each
646-D ___ inch {mm} * Valve with Box – per each
646-E ___ inch {mm} x ____ inch{mm} __* Hot Tap – per each
646-G ___ inch {mm} Steel Line Stoppers – per each
646-H ___ inch {mm} __*__ Valve with Box Reset - per each
646-J Gas _***_ – per each

* Show Type: Steel; Polyethylene
** Designate One Type: Main or Service Line.
*** Valve Box Reset, etc.

SECTION 649
ENCASEMENT PIPE FOR UTILITIES

649.01 Description.

This Section shall include the work of furnishing and installing an encasement pipe for a utility carrier pipe. An encasement pipe may be utilized as a carrier pipe as noted in this Section and when shown on the plans or directed by the Engineer.

The type of installation will be based on the location of the encasement pipe. The three types of installation are designated as follows:

Type 1 - Open cut.
Type 2 - Jack and bore, or tunneling.
Type 3 - Directional drilling.

The Contractor may substitute the Type 2 or Type 3 installation for the Type 1 installation if the substitution is done without extra compensation. Type 2 and Type 3 installations are intended for use under existing facilities and where traffic is not to be disturbed.

649.02 Materials.

Materials furnished for use shall conform to the requirements of Section 862, Utility Encasement Pipe and other appropriate sections of these Specifications.

The size and depth of pipe shall be as shown on the project plans or as described in the project proposal.

649.03 Construction Requirements.

(a) General.

Type 1 – encasement pipe installed by open trench method complying with requirements for installation and backfill given in Section 645.

Type 2 – encasement pipe installed by an approved jack and bore or tunneling procedure.

Type 3 – encasement pipe installed by directional drilling.

The encasement pipe shall be laid to the line and grade shown on the project plans.

All pipe and other materials shall be new and unused when delivered and shall be suitable for installation and operation under the condition for which they are intended. Any material that has mixed with or coated with dirt or foreign substances or damaged during its delivery or handling shall not be used.

Encasement pipe for a gas carrier pipe shall have two vent pipes installed to allow for release of gas in the event of a leak. The vents shall be installed within 1 foot {0.3 m} of the end of the encasement pipe. The vent located on the low end of the encasement shall be installed on the underside of the encasement and the vent located at the high end of the encasement shall be installed on the top of the encasement. The vent pipe shall slope upwards away from the encasement. The vent pipe shall be above ground unless otherwise noted on the project plans.

(b) Open Cut Method.

The procedure for excavating and backfilling by the open cut method shall be as prescribed in Section 645.

(c) Jack and Bore, or Tunneling Method.

1. General.

The Contractor shall submit the procedure proposed for the Type 2 installation (jack and bore, or tunneling) to the Engineer at least 7 calendar days prior to the beginning of the installation. The Engineer will not approve the submittal but will review it for completeness. Work shall not begin until the Engineer informs the Contractor that the submittal is complete. The submittal shall contain a list of all equipment proposed for use and a description of the procedure proposed for installation.

The encasement pipe shall be installed simultaneously with the boring action. The results of this procedure shall produce a neatly installed encasement pipe without damage to the existing facility (roadbed, slopes, etc.) and without excessive voids in the earth surrounding the encasement pipe. If there are indications that voids exist around the encasement, the Engineer will order the Contractor to pump a concrete grout under pressure to seal the voids. Any damage to the facility caused by the installation operation shall be restored by the Contractor to the satisfaction of the Engineer without cost to the Department or Utility.

2. Seating of Carrier Pipe.

Encasement pipe spacers shall be used to maintain separation of the encasement pipe and the carrier pipe to ensure stability of the carrier pipe. Spacers shall be either stainless steel or non-metallic as approved by the Engineer and shall be installed in accordance with the manufacturer's recommendations.

3. End Treatment of Encasement Pipes.

End seals shall be mechanically attached to the ends of the encasement pipe and to the carrier pipe to prevent the entrance of dirt and water into the encasement pipe.

(d) Directional Drill Method.

High density polyethylene (HDPE) pipe installed by the directional drilling method shall be as specified in Section 862. The HDPE pipe shall meet the requirements for the depth of embedment and loading.

Steel encasement pipe installed by directional drilling shall meet the requirements given in Section 862.

Steel encasement pipe for gas that is installed by directional drilling as a carrier pipe shall meet the requirements for gas pipe given in Section 861.

The Contractor shall submit to the Engineer the details of the procedure and equipment proposed for the directional drilling at least 7 calendar days prior to beginning the drilling. The directional drilling procedure shall produce a neatly installed carrier pipe without damage to the existing facility (roadbed, slopes, etc.) and without excessive voids in the earth surrounding the pipe. If there are indications that voids exist around the pipe, the Engineer will order the Contractor to pump under pressure a concrete grout to seal the voids. Any damage to the facility caused by the installation operation shall be restored by the Contractor to the satisfaction of the Engineer without cost to the Department or Utility.

Installation of the pipe shall meet the requirements of ASTM F 714. Joining of the HDPE pipe shall be performed by thermal butt-fusion in accordance with the pipe manufacturer's recommendations. The piping shall be assembled in a manner that does not obstruct adjacent roadways or public activities.

The pipe installed by the directional drill method shall be to the alignment and grade shown on the project plans. The Contractor shall provide a record drawing showing the constructed horizontal and vertical alignment shown for intervals not exceeding 30 feet {9.0 m}.

The Contractor shall perform the construction in a manner so that the drilling fluids and cuttings are contained and not released into waterways or their tributaries. The Contractor shall handle the HDPE and steel pipe in a manner that will not over stress the pipe at any time before, during, and after construction. A sizing pig shall be used to determine the presence of buckles, dents, out of roundness, and any other deformations. Anomalies shall not exceed 2% of the nominal pipe diameter or excessive ovality greater than 5% of the nominal pipe diameter.

649.04 Method of Measurement.

Encasement pipe will be measured by the linear foot {meter}.

649.05 Basis of Payment.

(a) Unit Price Coverage.

The encasement pipe will be paid for at the contract unit price bid for the type of installation required. The unit price bid shall be compensation in full for furnishing and installing the pipe, all excavation and backfill, vent pipes, spacers, end treatments, disposal of excess material and all labor, material, tools, equipment and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

649-A ___ inch {mm} _*_ Encasement Pipe, Type __**__ Installation - per linear foot {meter}

* Show Type: Steel; High Density Polyethylene(HDPE);etc.

** Show Type: 1, 2 or 3

SECTION 650
TOPSOIL

650.01 Description.

This Section shall cover the work of furnishing and placing topsoil and the placement of State furnished topsoil from stockpiles.

650.02 Materials.

(a) Required Properties of Topsoil.

Topsoil furnished or stockpiled by the Contractor shall meet the requirements given in ASTM D 5268 "Standard Specification for Topsoil for Landscape Purposes". The composition of the topsoil shall be as follows (from ASTM D 5268):

REQUIRED PROPERTIES OF TOPSOIL	
Deleterious Materials (rock, gravel, slag, cinder, roots, sod) in the Total Sample	7 % maximum by weight {mass}
Organic Material in Portion of Sample Passing the No. 10 {2 mm} Sieve	2 % to 20 % by weight {mass}
Sand Content in Portion of Sample Passing the No. 10 {2 mm} Sieve	10 % to 90 % by weight {mass}
Silt and Clay Content in Portion of Sample Passing the No. 10 {2 mm} Sieve	10 % to 90 % by weight {mass}
pH	5 to 7

Topsoil will be sampled at the source and tested prior to application by the Engineer in accordance with ASTM D 5268 for compliance with these requirements.

(b) Sources of Topsoil.

1. Topsoil Furnished by Contractor.

Topsoil furnished by the Contractor shall be taken from areas outside of the Right of Way. The areas where topsoil is removed shall be developed, maintained and restored in accordance with the requirements given in Subarticle 106.01(b).

2. Topsoil Furnished by the State from Stockpiles.

The Contractor shall use topsoil from stockpiles that were created in accordance with the requirements given in Subarticle 210.03(b).

650.03 Construction Requirements.

(a) Preparation for Topsoil Placement.

The Contractor shall not place topsoil from any source (Contractor furnished or State furnished) until the Engineer has been given the opportunity to sample, test and evaluate the source for compliance.

The grading and shaping of the area where topsoil must be placed shall be completed prior to the placement of the topsoil unless directed otherwise by the Engineer.

(b) Application of Topsoil.

Topsoil shall be applied to the depth shown on the plans or as directed by the Engineer. Applied topsoil shall be compacted by tracking. Tracking shall be accomplished by the operation of a tracked vehicle leaving ridges perpendicular to the direction flow of water down the slope. The topsoil shall then be prepared in accordance with the requirements given in 652.03. Ground preparation and vegetation establishment operations shall commence as soon as possible after the application of topsoil to reduce the potential for the erosion of the topsoil.

(c) Portions of Stockpiles that remain after Removal of Topsoil.

Portions of stockpiles that remain after the removal of topsoil shall be reshaped as directed by the Engineer. Any additional temporary or permanent seeding, mulching and other erosion control measures that are required will be paid for under the appropriate items of work.

650.04 Method of Measurement.

(a) Topsoil, Item 650-A.

This item covers topsoil material furnished by the Contractor. Topsoil furnished by the Contractor will be measured in cubic yards {cubic meters} by loose measure in the delivery vehicle at the point of delivery.

(b) Topsoil from Stockpiles, Item 650-B.

This item covers topsoil made available to the Contractor in State furnished stockpiles on the Right of Way. This topsoil will be measured in cubic yards {cubic meters} by the cross section and average end areas method at the stockpile.

650.05 Basis of Payment.

(a) Unit Price Coverage.

Topsoil will be paid for at the contract unit price per cubic yard {cubic meter}, which shall be full payment for furnishing the topsoil, ground preparation handling, hauling, spreading, shaping, harrowing, disking, compaction, disposal of unacceptable material, and for furnishing all equipment, tools, labor and incidentals necessary to complete the work.

Topsoil from Stockpiles will be paid for at the contract unit price per cubic yard {cubic meter}, which shall be full payment for ground preparation, cleaning and removing debris from the topsoil, handling, hauling, spreading, shaping, harrowing, disking, compaction, and for furnishing all equipment, tools, labor and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

650-A Topsoil - per cubic yard {cubic meter}
650-B Topsoil from Stockpiles - per cubic yard {cubic meter}

SECTION 652
GROUND PREPARATION, VEGETATION ESTABLISHMENT AND MOWING

652.01 Description.

This Section shall cover ground preparation work and the work of establishing an acceptable permanent stand of vegetation of the species designated for establishment. This section also covers mowing of vegetated areas.

652.02 Materials.

Materials (seed mixes, mulch, fertilizer, etc.) shall be furnished in compliance with the requirements given in Section 860.

652.03 Construction Requirements.

(a) Construction Sequence.

The required sequence and timing of the placement of permanent seeding during excavation and embankment construction is given in Subarticle 210.03(a). The Engineer may direct, even to the exclusion of other operations, that the Contractor promptly complete grading and ground preparation to allow the establishment of permanent vegetation in areas where it is necessary for the control of erosion and sediment.

(b) Seed Mixes for the Establishment of Permanent Vegetation.

The appropriate seed mix shall be chosen from tables in Section 860. The appropriate seed mix is based on planting zone, planting date, and type of area to be seeded. Seed mixes of a temporary nature are required in some areas of the State when permanent seed mixes are out of season. These mixes are shown in Section 860 as requiring seeding in stubble for the establishment of the required permanent plant.

(c) Inspection.

The Contractor shall notify the Project Manager at least 48 hours in advance of any work related to seeding. This includes the mixing of seed as well as the sowing of seed. The Contractor shall notify the Engineer of the proposed type of seed mix or mixes to be incorporated into the project prior to beginning seeding operations. Seeding work shall not begin prior to the measurement of the area to be seeded. All work shall be performed in the presence of the Engineer.

(d) Preparation and Planting in Soft Soil.

1. Ground Preparation.

After grading and topsoil placement and prior to ground preparation, the Contractor shall remove all boulders, stumps, roots, or other objects with any dimension larger than 2 inches {50 mm}. Topsoil shall meet the requirements given in Section 650.

Ground preparation shall consist of cultivating the topsoil to a loose depth of at least 4 inches {100 mm} except on slopes 2:1 or steeper. The plowing, harrowing, cultivating, and all other operations shall be performed with proper equipment and in such a manner as to break up all clods.

The ground shall be plowed to the required depth and then cultivated with a rotary tiller or disk harrow, in crossing directions if necessary, until the result is a smooth, uniform, loose, and well broken soil providing a suitable bed for seed. In small or inaccessible areas the use of hand tools will be permitted. The Contractor shall add water as necessary to provide sufficient soil moisture to prepare the ground.

All trash and other debris shall be removed from the cultivated topsoil. All pieces of wood, rocks and unbroken clumps of earth with any dimension larger than 2 inches {50 mm} shall be removed from the planting area.

2. Initial Soil Amendments.

The initial fertilization shall be a commercial fertilizer that will provide at least 120 pounds {135 kg} of N, 120 pounds {135 kg} of P_2O_5, and 120 pounds {135 kg} of K_2O per acre {hectare}, as computed from the nominal contents of fertilizer elements. Only one half of this rate shall be applied when the required seeding is Annual Ryegrass. Agricultural limestone (lime) shall be applied prior to

seeding at a rate of two tons per acre {4.5 metric tons per hectare}. Lime may be applied in dry, pelletized or slurry form. The rate of application is required regardless of the form of application.

The required rates of placement of fertilizer and lime may increase as directed by the Engineer based on the results of the testing of the Topsoil from Stockpiles as described in Article 650.02. Additional fertilizer and lime for Topsoil from Stockpiles will be paid for separately in accordance with the requirements given in Article 652.05. Reductions in rates will result in a price adjustment for seeding.

Fertilizers and agricultural limestone (lime) shall be applied uniformly at the required rates of placement. The fertilizer shall be well pulverized and free of lumps when applied. In no case shall fertilizer that is not mixed with soil be permitted to be in direct contact with seed. When fertilizers are applied hydraulically they shall be diluted sufficiently so that no damage is done to either seed or established vegetation. Agricultural limestone, basic slag or a combination of limestone and slag shall be applied separately but may be incorporated into the soil with fertilizers in one operation.

Fertilizer and agricultural limestone that is not applied hydraulically shall be uniformly mixed with the soil by harrows, rotary tillers, or other soil mixing equipment prior to subsequent operations. Mixing with the soil will not be required when the fertilizer and agricultural limestone is applied hydraulically.

3. Sowing Seed.

Mechanical or hydraulic seeders shall be used for sowing unless approved otherwise by the Engineer.

Sowing shall not be performed during windy weather, when the prepared surface is crusted, or when the ground is frozen, wet or otherwise in a non-tillable condition. The addition of water may be required to render excessively dry soils tillable.

Equipment for applying seed hydraulically shall be designed for this purpose. The equipment shall be capable of mixing and pumping the water, seed mixture, mulch and fertilizer uniformly over the area to be seeded. Power driven agitators shall be provided to keep the mixture uniform during the application.

4. Covering Seed.

Care shall be exercised during covering operations to preserve the line, grade and cross-section of the seeded areas so that areas adjacent to pavement, walks, etc., are not left higher than the paved surface. The seed bed shall be compacted immediately after sowing. Compaction shall be done with a cultipacker, light roller or approved drag. The weight {mass} of the roller or drag needed shall be determined by the Contractor according to the type and physical condition of the soil. Rolling or covering of seed may be omitted when both seeding and mulching are hydraulically applied.

5. Mulching.

Mulching shall be applied in accordance with the requirements given in Section 656. Seeded areas shall be covered with mulch within 48 hours after seeding. Mulching will be measured and paid for separately under Section 656.

6. Soil Amendments After Growth.

After the required plant species have emerged and shown normal growth (usually approximately 40 days) and while the soil surface is moist, a second application of fertilizer shall be made. This second application shall be placed as a uniformly applied top dressing of 40 pounds {45kg} each of N, P_2O_5, and K_2O per acre {hectare}, respectively or equivalent approved by the Engineer.

This application of fertilizer will not be required for temporary planting (Annual Ryegrass).

(e) Preparation and Planting in Rocky or Hardpan Areas.

1. Conditions for Planting in Rocky Areas.

The requirements for planting in rocky or hardpan areas shall apply when the Engineer determines that the area is too rocky or compacted for plowing, disking, and harrowing, but is sufficiently soft or shaley to permit some form of treatment

2. Initial Soil Amendments.

One half of the fertilizer and all of the lime required for the initial fertilization of soft soil shall be applied before the initial scarification.

3. Initial Scarification.

The fertilizer and lime shall be worked into the rocky or hardpan area by an initial scarification as directed by the Engineer.

4. Coverage with Topsoil.

Approximately 4 inches {100 mm} of topsoil shall be placed over the scarified and fertilized rocky or hardpan area.

5. Soil Amendments after Placement of Topsoil.

The second half of the fertilizer required for the initial fertilization of soft soil shall be applied after the placement of the topsoil.

6. Sowing, Covering, Mulching and Fertilizing after Growth.

The sowing of the seeds, covering of the seeds, mulching, and fertilization after growth of the seeds shall be in accordance with the requirements given for this work in soft soil.

(f) Preparation and Planting on Steep Slopes (2H:1V or Steeper).

1. Ground Preparation.

Planting operations may proceed without further ground preparation after topsoil spreading and tracking if the planting can be accomplished within 72 hours after the tracking operations. Tracking is the mechanical roughening of the slope surface. Tracking shall be accomplished by the movement upslope and downslope (not along the slope) of heavy equipment that operates on tracks.

2. Initial Soil Amendments.

One half of the fertilizer and all of the lime required for the initial fertilization of soft soil shall be applied hydraulically.

3. Sowing.

The sowing of seeds shall be in accordance with the requirements given for this work in soft soil with the exception that hydraulic seed application is required.

4. Mulching.

Mulching shall be applied in accordance with the requirements given in Section 656. Seeded areas shall be covered with mulch within 48 hours after seeding. Mulching will be measured and paid for separately in accordance with the requirements given in Section 656.

5. Second Application of Fertilizer after Mulching.

Half of the fertilizer required for the initial fertilization of soft soil shall be applied hydraulically approximately 40 calendar days after mulching.

6. Third Application of Fertilizer.

A third application of fertilizer shall be made approximately 40 calendar days after the second application of fertilizer. This application shall be placed hydraulically as a uniformly applied top dressing of 500 pounds {560 kg} of 8-8-8 fertilizer per acre {hectare} or equivalent approved by the Engineer.

(g) Seeding in Stubble.

The seeding in stubble method of planting shall be used to establish permanent species when initial vegetation establishment occurs during a season that is not optimal for the permanent planting. Dates for seeding in stubble are designated in the seed mix tables in Section 860.

This method requires that the existing vegetation be mowed to a height of approximately 3 inches {75 mm} or sprayed with an approved herbicide, or both, to retard further growth. The area shall then be lightly scarified by disking or other approved method to prepare a suitable seedbed. The initial fertilization, sowing of the seeds, covering of the seeds, and fertilization after growth of the seeds shall be in accordance with the requirements given for this work in soft soil. Additional agricultural lime application will not be required for seeding in stubble. Mulch may be applied to bare areas if requested by the Contractor and approved by the Engineer. Mulch shall be furnished and paid for in accordance with the requirements given in Section 656.

(h) Establishment and Acceptance.

All work shall be conducted in accordance with the requirements given in Section 665 as well as the requirements given in this Section.

The Contractor shall provide plant establishment of the required species of permanent vegetation prior to final acceptance of the project. Plant establishment shall consist of preserving, protecting, reseeding, or replanting and other such work and at such time as may be necessary to keep the vegetated areas in a satisfactory condition. All of the above work shall be performed without additional compensation, unless otherwise specified.

The acceptance of designated seeded areas will be based upon verification of a satisfactory stand of vegetative cover in the season for each species required for establishment. If a satisfactory stand of

desired vegetation is not established, the area shall be re-seeded after appropriate soil preparation and re-established without additional cost to the Department.

A satisfactory stand of vegetative cover shall be defined as a cover of living plants, after true leaves are formed, of the required seed species designated for establishment. Generally an 85 % coverage will be considered acceptable. Should the Contractor protest the determination of satisfactory stand based on visual analysis, a random sampling of 5 samples per acre {0.4 ha} using a square yard {meter} template may be executed to determine the percent coverage. There should be no areas void of the required species larger than 4 square feet {0.4 square meter}. Payment for seeding, fertilizer, and agricultural limestone and mulch will be made in full upon satisfactory application. Payment for additional fertilizer and agricultural limestone will be made in accordance with the requirements given in Article 652.05. Payment for seeding may be withdrawn for areas where vegetative cover is not established or not satisfactorily maintained and fertilized after establishment.

Every effort should be made to establish vegetation of permanent species in accordance with the seasonal requirements shown for each species in Section 860. Areas where the season and required seed mix cause the method of seeding in stubble to be necessary for the establishment of a permanent plant will not be considered acceptable until vegetation of a permanent species is satisfactorily established. The project will not be accepted for maintenance prior to acceptable establishment of vegetation after seeding in stubble.

Payment will not be made for areas of unsatisfactory stands of vegetative cover, the repair of areas damaged by the Contractor, or for the repair of washes in areas where sufficient erosion control measures are available to the Contractor.

Requests from the Contractor for payment for areas of unsatisfactory stands of vegetative cover will not be considered by the Construction Engineer without the submittal of documentation of absolute adherence to the requirements for the application of topsoil and for the establishment of the vegetation.

(i) Mowing.

The Contractor shall mow all seeded areas of medians, shoulders and front slopes as directed or permitted by the Engineer. The Contractor shall mow when the vegetation becomes a hazard to motorists and as necessary to promote growth of the required permanent plant. Mowing shall be performed in a manner that will not cause unnecessary damage to desirable vegetation. Mowing of lespedezas and tall fescue shall not be done until after these plants have produced mature seed.

Mowing shall generally be done twice each year as directed or permitted by the Engineer and when vegetation has grown to a height of 16 inches. If the project is being considered for acceptance for maintenance by the Department and has been mowed within the last 2 months, additional mowing will not be required.

The Contractor shall mow, cut and trim as close as practicable to all fixed objects, exercising extreme care not to damage trees, plants, shrubs, delineators and other appurtenances. Damage to trees, plants, shrubs, delineators or other appurtenances shall be repaired or replaced immediately by the Contractor at no cost to the Department. The Engineer will determine if the damage must be corrected by repair or replacement.

652.04 Method of Measurement.

(a) Seeding.

Seeding will be measured in acres {hectares} parallel to the seeded surface regardless of the method of establishment.

(b) Mowing.

Mowing will be measured in acres {hectares} parallel to the mowed surface. Each separate mowing of the same location will be measured separately.

652.05 Basis of Payment.

(a) Unit Price Coverage.

Seeding will be paid for at the contract unit price per acre {hectare} which shall be full compensation for all ground preparation, furnishing, preparing, soil amendments (fertilizer and lime), seeds, including water needed in mixing, planting, establishing, and maintaining of the seeded areas until final acceptance, and for all materials, equipment, tools, labor, and incidentals necessary to complete the work. Additional fertilizer or agricultural limestone ordered by the Engineer will be paid at the verified invoice price plus 15 percent. The seeding item will be used for payment for establishing

vegetation regardless of the methods used for planting and establishment. Vegetation established outside of the normal planting season (annual ryegrass) will be paid for at the contract price for seeding. Vegetation established by seeding in stubble will also be paid for at the contract unit price for seeding.

All mowing, cutting and trimming, including mowing required for seeding in stubble will be paid for at the contract unit price bid per acre {hectare} which shall be payment in full for the mowing including equipment, labor, and incidentals necessary to complete this item of work. The contract unit price shall also be for mowing required when the vegetation becomes a hazard to motorists and as necessary to promote growth of the required permanent vegetation.

(b) Payment will be made under Item No.:

652-A Seeding - per acre {hectare}
652-C Mowing - per acre {hectare}

SECTION 654
SOLID SODDING

654.01 Description.

This Section shall cover the work of furnishing solid grass sodding in designated locations throughout the construction limits of the work. Basic work consists of ground preparation, furnishing and placing required soil amendments, and furnishing and installing sod and maintenance of the sod including watering of the sod for the life of the contract.

654.02 Materials.

All materials shall conform to the requirements of Article 860.05. A list of acceptable mulch control netting products (LIST II-20, "TACKIFIERS, MULCH CONTROL NETTING, AND HYDRAULIC MULCH PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements".

654.03 Construction Requirements.

Areas to receive sod shall be prepared in accordance with the requirements for planting vegetation in soft soil given in Section 652. The requirements for ground preparation and the application of initial and final amendments to the soil shall apply to this work. The sod shall be placed on the prepared and amended soil with no gaps between the individual sod pieces or rolls. The entire sodded area shall be rolled with a weighted roller to set each piece of sod into the topsoil. Staking or stapling of sod is required on slopes 3:1 or steeper and all channel applications and shall be done without additional compensation. When required by the plans, mulch control netting shall be applied in accordance with Section 656 and shall be a subsidiary obligation.

The Contractor shall water, fill washes, and otherwise protect and maintain all sodded areas until the contract is accepted for maintenance or until the bond is released if a bond was required. Payment will not be made for areas of unsatisfactory stands of vegetative cover, the repair of areas damaged by the Contractor, or for the repair of washes in areas where sufficient erosion control measures are available to the Contractor. Requests from the Contractor for payment for areas of unsatisfactory sod will not be considered without the submittal of documentation of absolute adherence to the requirements for the establishment of the solid sodding.

The requirements given in Section 652 shall apply to the determination of a satisfactory installation of solid sod except that a 95 % living coverage will be required.

654.04 Method of Measurement.

Solid Sodding will be measured in square yards {square meters} from measurements made parallel to the surface of the area covered by the sod.

654.05 Basis of Payment.

(a) Unit Price Coverage.

Solid Sodding will be paid for at the contract unit price, which price shall be full compensation for furnishing the sod, ground preparation, planting, soil amendments, rolling, watering, and maintaining the sod until acceptance of the contract, and for all other materials, equipment, tools, and labor

necessary to complete the work. Additional fertilizer or agricultural limestone ordered by the Engineer will be paid at the verified invoice price plus 15 percent.

(b) Payment will be made under Item No.:

654-A Solid Sodding - per square yard {square meter}

SECTION 656
MULCHING FOR VEGETATION ESTABLISHMENT

656.01 Description.

This Section shall cover the work of furnishing and placing mulching materials over the soil surface to provide protection from soil erosion and to aid in retention of soil moisture for vegetation establishment.

656.02 Materials.

Mulch materials shall be furnished in compliance with the requirements given in Article 860.03. A list of acceptable Hydraulic Mulch products, Mulch Control Netting and Tackifiers (List II-20, "TACKIFIERS, MULCH CONTROL NETTING, AND HYDRAULIC MULCH PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements".

656.03 Construction Requirements.

(a) Mulching Operations.

Seeded areas shall be covered with mulch within 48 hours after seeding. Mulch shall be applied at the rates required below for the type of mulch used. Mulch shall be furnished to effectively control erosion and promote the establishment of vegetation.

Dry blown mulch shall be stabilized by crimping, by the application of a tackifier adhesive, or by anchoring with a mulch control netting, with the following exceptions: crimping shall only be allowed on slopes 3:1 or flatter, and tackifier adhesive shall be required for applications within 10 feet {3 meters} of traffic. During crimping operations, care shall be taken to follow as closely as possible to the contours of the mulched surface. Crimping shall result in the mulch being securely lodged into the soil providing both erosion protection and promotion of vegetation establishment. Tackifier adhesive shall be applied at the rate recommended by the manufacturer.

Hydraulic Mulch products shall be applied in accordance with manufacturer recommendations, typically in opposing directions to provide a solid blanket of mulch product. Hydraulic Mulches may be used within 10 feet {3 meters} of traffic as an alternate to dry blown mulch with tackifier adhesive. Hydraulic Mulches and tackifiers shall not be installed in areas subject to channelized flow or areas having a potential to flood during a local 2 year, 24 hour storm event.

(b) Rate of Mulch Application.

Dry blown mulch shall be applied at a rate of not less than 2 tons per acre {4500 kg/ha}. Proof of material weight shall be provided to the Engineer by the Contractor upon delivery of the materials to the project site. The weight ticket shall contain all items required in Item 109.01(h)2. with the exception of the name of the producer and the truck number.

Hydraulic Mulch products shall be applied at the rate designated by the manufacturer for the specific slope where they are being applied to provide a solid blanket of the mulch product with no soil showing. In no case shall the applied rate be less than 1 ton per acre {2250 kg/ha} for hydraulically applied mulches.

The application rate will be verified by using the air dry weight {mass} per pound {kilogram} and dividing by the surface dimensions of the area covered.

(c) Equipment.

Dry blown mulch shall be applied with a mechanical mulch spreader designed to break up balls or clusters of mulch. If a tackifier adhesive is used to secure the mulch, the mulch spreader shall be equipped to apply the adhesive effectively to the mulch to form a uniform, porous and stable mulch blanket held in place by the adhesive. The adhesive may also be applied hydraulically after mulch application.

Crimpers shall be roller-type devices equipped with flat, uncupped, dull edged disks. The disks shall have a minimum width of 1/4 of an inch {6 mm} and shall be placed a maximum of 8 inches {200

mm} apart along the axle or shaft. Crimpers shall be specially designed so that by adding weight {mass} or using hydraulic force from the tractor the mulch will be imbedded a minimum of 2 inches {50 mm} into the ground. The diameter of the disks shall be large enough to prevent the axle or shaft from dragging or in any way disturbing the mulch or soil. Under no circumstances shall a disc harrow be used to perform the crimping operation.

Hydraulic mulch application shall be performed using equipment designed for this purpose and that is in compliance with the recommendations of the mulch product manufacturer.

656.04 Method of Measurement.

Mulch will be measured by the acre {hectare} of the finished surface dimensions of the area ordered treated.

656.05 Basis of Payment.

(a) Unit Price Coverage.

Mulch will be paid for at the contract unit price which shall be payment in full for materials, including tackifiers or mulch control netting (if used), equipment, tools and labor necessary to furnish, place and maintain the mulch.

Payment for this work will be made upon satisfactory application of the mulching.

(b) Payment will be made under Item No.:

656-A Mulching - per acre {hectare}

SECTION 659
ROLLED AND HYDRAULIC EROSION CONTROL PRODUCTS

659.01 Description.

This Section shall cover the work of furnishing, installing, and maintaining Rolled Erosion Control Products (RECPs) and Hydraulic Erosion Control Products (HECPs). RECPs and HECPs will be referred to as “erosion control products” in this section. Areas to be covered by erosion control products (ECPs) will be shown on the plans or will be designated by the Engineer.

659.02 Materials.

(a) Acceptable Erosion Control Products.

Erosion control products shall be furnished in compliance with the requirements given in Article 860.11. A list of acceptable erosion control products (LIST II-11 "ROLLED AND HYDRAULIC EROSION CONTROL PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning the list and manual is given in Subarticle 106.01(f) and ALDOT-355 "General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements".

(b) Utilization of Erosion Control Products.

Erosion control products shall utilized as the final stabilization layer in conjunction with the required permanent vegetation.

1. Degradable Erosion Control Products.

Degradable ECP's shall be furnished to effectively control erosion and enhance the establishment of vegetation during a defined minimum period of time called "functional longevity". The Contractor shall be responsible for selecting approved ECPs with a functional longevity of sufficient duration to allow establishment of permanent vegetation prior to product degradation or as shown on the plans or as designated by the Engineer.

2. Permanent Erosion Control Products.

Permanent ECPs shall be furnished to effectively control erosion, enhance the establishment of vegetation, and permanently reinforce vegetation for applications where permanent vegetation alone will not provide sufficient protection against anticipated erosive forces.

(c) Selection of Erosion Control Products.

ECPs will be specified based on the characteristics of the intended application site. The maximum slope or the maximum anticipated channel shear stress from the flow of water is given in the following table for each type of erosion control product.

EROSION CONTROL PRODUCTS			
Product Application	ECP Type	Maximum Slope (H:V)	Maximum Anticipated Channel Shear Stress[1] (Pounds per Square Foot)
Slope	S4	4:1	-
	S3	3:1	-
	S2	2:1	-
	S1	1:1	-
Channel	C2	-	2.0
	C4	-	4.0
	C6	-	6.0
	C8	-	8.0
	C10	-	10.0

NOTE 1 (in the table of ECPs) : The approximate shear stress that an ECP would be exposed to in a channel may be calculated from the formula:

Approximate Shear Stress = g X D X S_b

g = Unit weight of water: 62.4 pounds per cubic foot;

D = maximum expected depth of water in the channel (feet);

S_b = slope of bed in (feet per foot).

659.03 Construction Requirements.

(a) Required Type of ECP.

The Contractor shall furnish the Type of ECP shown on the plans or designated by the Engineer. Unless shown otherwise on the plans, RECPs and HECPs may be used interchangeably if equivalent RECPs and HECPs are approved for use. The required Type of ECP shall not be changed without the written approval of the Engineer. Areas requiring rapidly degrading or no-net products will be shown on the plans.

If the required Type of ECP is not available to be selected from List II-11, the Contractor shall furnish a more substantial ECP from List II-11 without additional compensation. (For example, if a Type S3 ECP is shown to be required on the plans, and there are no Type S3 products shown in List II-11, Type S2 or Type S1 will be an acceptable substitute. Similarly, if a Type C4 ECP is shown to be required on the plans, and there are no Type C4 products shown in List II-11, Types C6, C8 or C10 will be an acceptable substitute.)

(b) Preliminary Preparation.

Prior to placement of the ECP, the area shall have been prepared in accordance with the required ground preparation, fertilizing, seeding or other required treatment. It is important that the soil surface is smooth to ensure maximum surface area contact with the ECP.

(c) Installation of ECP.

The Contractor shall submit the ECP manufacturer's installation requirements, including staple patterns for rolled ECPs, to the Engineer before beginning the installation. The ECP shall be installed in accordance with the manufacturer's requirements unless directed otherwise by the Engineer.

Rolled ECP typical installation shall be parallel to the direction of flow. There shall be an anchor trench at the top of the installation. Upstream RECPs shall overlap any downstream RECPs. Adjacent RECPS shall also be overlapped. Staples shall be placed on overlaps, at the toe of the RECP, and throughout the RECP installation to ensure the RECP is in contact with the underlying soil.

Rolled ECPs that are soil-filled permanent turf reinforcement mats will require either a temporary rolled erosion control product or sod installed on the soil surface to prevent erosion until permanent vegetation is established.

Hydraulic ECP typical installation shall be in opposing directions to provide a solid blanket of product. HECPs shall be applied by equipment that meets the recommendations of the product

manufacturer. HECPs shall be applied at the rate designated by the manufacturer specific to the slope. The application rate will be verified by measuring the air dry weight {mass} per pound {kilogram} and dividing by the surface dimensions of the area covered. HECPs should not be installed in areas subject to channelized flow or areas having a potential to flood during a local 2 year, 24 hour storm event.

(d) Protection of ECP.

The ECPs shall be protected during all construction operations. Payment will not be made for the repair or replacement of the ECPs damaged by the Contractor, or for the repair or replacement of ECPs that fail because of improper installation.

659.04 Method of Measurement.

Erosion control products (ECPs) will be measured by the square yard {square meter} of the finished surface dimensions of the area covered. Separate measurement will not be made for folds, laps, check slots, anchor slots, etc.

659.05 Basis of Payment.

(a) Unit Price Coverage.

ECPs will be paid for at the contract unit price, which shall be full compensation for the furnishing and installation of the product including all materials, equipment, tools, labor and incidentals required to complete this item of work.

(b) Payment will be made under Item No.:

659-C Erosion Control Product, Type __*__ - per square yard {square meter}

* Type of ECP: S4, S3, S2, S1, C2, C4, C6, C8, C10

SECTION 660
VINES, SHRUBS AND TREE PLANTING

660.01 Description.

This Section shall cover the work of furnishing, planting, and establishing healthy, live, growing trees, shrubs, seedlings, vines or other designated plants at designated locations on the project. The specie, size, etc. of vines, shrubs, seedlings and trees will be as indicated on the plans or proposal.

Basic work consists of furnishing or harvesting of plants and transporting thereof; preparation of plant site or beds including furnishing and preparation of soil, fertilizer, mulch and other miscellaneous items incidental to the planting procedure; the planting of the plants in a workmanlike manner in accordance with accepted horticultural practices along with the water necessary to establish and maintain the plants in a live, growing condition throughout the life of the project. The amount of water to be used and when it shall be applied shall be the Contractor's responsibility until acceptance of the project.

660.02 Materials.

All materials shall conform to the requirements of Division 800, Materials. Specific reference is made to Roadside Improvement Materials, Section 860.

660.03 Construction Requirements.

(a) General.

All planting operations for vines, shrubs and trees shall be done under the on-site, direct supervision of a person possessing a current and valid professional services permit for the Setting of Landscape Plants and a Nursery Dealer Certificate issued by the Alabama Department of Agriculture and Industries. Proof of the possession of these permits shall be furnished to the Engineer prior to the commencement of work. Any work performed without the on-site, direct supervision of these permitted individuals will be subject to rejection by the Engineer.

The normal growing period for vines, shrubs, and trees is defined as that time period between April 1 and September 30. All vines, shrubs and trees shall be planted so as to provide the maximum growing time allowable under the contract time. All plantings shall be scheduled to provide a minimum of one growing season except as noted in Subarticle 860.06(b).

Pine seedlings shall be planted in North Alabama only between December 1 and March 15; in South Alabama only between December 1 and February 15. Planting will not be permitted during periods of drought or when the ground is frozen. These seasonal limits may be changed only on written orders from the Engineer.

Any rock or underground obstructions shall be removed to the depth necessary to permit planting according to the plans and Specifications unless other locations for the planting are approved. Explosives may be used only where and as expressly approved.

(b) Planting Operations for Vines, Shrubs and Trees.

1. Row Planting.

a. Furrows or trenches shall be opened in the locations designated to a depth at least 6 inches {150 mm} greater than the depth of the roots or ball when extended in their normal position, and in no case less than 12 inches {300 mm} for vines and shrubs. The width of furrows or trenches shall be at least 12 inches {300 mm} greater than the spread of the roots when extended in their normal position, and in no case less than 12 inches {300 mm} for vines and 18 inches {450 mm} for shrubs.

b. The furrows or trenches shall then be partially filled with prepared plant topsoil and the vines or shrubs placed so that the crown, bud or base of the tops, as the case may be, is at or slightly below the previous growing level and the roots are in a natural spread. After the roots have been completely covered with plant topsoil, the commercial fertilizer 8-8-8 shall be evenly scattered over the surface of the plant topsoil at the rate of approximately 0.1 pound per foot {0.15 kg per meter} of furrow or trench, followed by a satisfactory watering. After the water has soaked in and the plant topsoil is no longer muddy, additional plant topsoil shall be added and firmly compacted. Compaction shall stop when the compacted plant topsoil is 2 inches {50 mm} below the finished grade. The balance of the furrow or trench shall then be filled with loose plant topsoil until it is slightly lower than the finished grade.

2. Spot Planting.

Planting operations shall be in accordance with the specifications for row planting as far as applicable. Commercial fertilizer, 8-8-8, shall be applied at a rate of 0.1 pound per square yard {0.05 kg per square meter}. Pits for trees and shrubs shall not be less than 18 inches {450 mm} deep and 3 feet {900 mm} in diameter unless otherwise shown on the plans. If the trees to be planted are larger than 2 inches {50 mm} in caliper or 10 feet {3 m} in height, the size of the pits shall be increased in proportion to the increase in size of the trees. For shrubs the pit shall be 12 inches {300 mm} greater than the ball diameter or root spread. The bottom of all planting pits for trees shall have the soil loosened at least 6 inches {150 mm} deeper than excavated. The side walls of all planting pits shall be vertical and the bottoms flat. Sloping walls of pits or crowding of root systems will be cause for rejection of the planting.

3. Drainage.

Tile or pipe underdrain subsoil drainage shall be installed as provided by the plans or directed. Such tile pipe shall meet the requirements of Section 853. Trenches shall be not less than 18 inches {450 mm} below finished grades. Drain tile shall be connected with a suitable outlet.

4. Disposal of Excess Soil.

Excess soil shall be disposed of as directed.

5. Plant Topsoil.

Unless otherwise provided by the plans, plant topsoil shall be used in preparation and in the backfill of plant pits in connection with row planting and spot planting.

6. Setting Plants.

a. All plants shall be set plumb at such a level that after settlement they bear the same relation to the level of the surrounding ground as they bore to the ground from which they were dug. All plants shall be planted in plant topsoil which shall be settled by watering when required and by tamping. For spring planting, a shallow saucer capable of holding water shall be formed about each plant by placing a mound of soil around the edge of each pit, unless otherwise directed. Care shall be taken in setting plants to protect adjacent planting from damage.

b. Balled and burlapped plants or balled platform plants (BB, BP) are to be planted with plant topsoil carefully tamped around and under the base of each ball to fill voids. Platforms shall be removed. All cloth, ropes, et cetera, shall be removed from the tops of balls, but no cloth shall be pulled out from under the balls.

c. Roots or bare-root (BR) plants shall be properly spread out in a natural position and plant topsoil shall be carefully worked in among them. All broken and frayed roots shall be cleanly cut off.

(c) Planting Operations for Seedlings.

1. General.

The pine seedlings shall be transported to the planting area in a manner that will protect the roots from the wind and sun and guard against skinning or otherwise damaging the plant or root system. The roots shall be kept moist at all times. The recommended method of hand planting is shown in detail on the plans. Seedlings shall be placed in the hole to an approximate depth of 1/4 of an inch {6 mm} deeper than the depth the plant grew in the nursery. Care shall be taken not to bend or fold the roots due to a small shallow hole. Planting by use of a soil auger will be acceptable, if care is taken to remove the air pockets by packing to ground level.

2. Fertilizer.

No extra fertilizer will be required on areas that have been previously fertilized, fertilizer will be applied as directed by the Engineer, and payments made for extra fertilizer quantities provided on the plans.

3. Spacing.

The seedlings shall be spaced approximately 6 feet {1800 mm} on centers, or as shown on the plans, planting in an irregular pattern as outlined by the Engineer.

(d) Pruning.

All pruning shall be done on the site before planting in accordance with the schematic drawings provided in the plans and as directed. Pruning shall follow modern horticultural practices (American Standard for Nursery Stock) and shall be done with approved tools designed for the purpose intended. Lopping, topping or shearing of trees or shrubs will be grounds for rejecting the plants as unsuitable and not meeting the requirements. Damaged, scarred, frayed, split, or skinned branches, limbs or roots shall be pruned back to live wood nearest to the next sound outside lateral bud, branch, limb or root. The terminal leader or bud in all trees or shrubs shall be left intact and not removed unless damaged. The top growth of all vines shall be cut back approximately one-third unless otherwise directed.

(e) Guying, Staking and Wrapping of Trees.

1. Guying and Staking.

All trees shall be staked or guyed unless otherwise directed. Unless otherwise directed, all trees up to 2 inches {50 mm} in caliper, or up to 10 feet {3 m} in height, shall be supported by a single 8 foot {2.5 m} (above ground line) stake; all trees from 2 inch {50 mm} caliper up to 3.5 inch {100 mm} caliper, or from 10 to 14 feet {3 to 4.2 m} in height, shall be supported by two 10 foot {3 m} (above ground line) stakes. All trees from 4 to 6 inch {100 to 150 mm} caliper shall be supported by 4 stakes at least 12 feet {3.6 m} (above ground line) long. All stakes shall be at least 2 feet {600 mm} in the ground. All trees larger than 5 inch {125 mm} caliper, or other trees with heavy crowns shall be supported by anchored wires and guyed 3 ways with double No. 10 wire. Stakes shall not injure plant balls. No. 12 wire and rubber hose, or approved substitutes, shall be used to secure the tree to stakes without chafing or injury. Wires used for guying shall be secured to the tree by passing through a rubber hose, by using wood stakes protected from the bark by heavy cloth padding, or by similar means to prevent chafing and injury at a point approximately 2/5 of the height of the tree. Guy wires shall be anchored in the ground to stakes or deadmen at a distance from the trunk of about 3/4 of the height of fastening. Guy wires shall be tightened by driving the stakes, leaving subsequent tightening to be done by maintenance forces by twisting the wires.

2. Wrapping.

Trees shall have their bark protected from transpiration using Method A, B, or C.

a. Method A.

All trunks and branches shall be sprayed with "Dowax" or similar approved wax compound immediately before or after digging, The material shall be applied as directed by the manufacturer.

b. Method B.

The trunks of all trees, from the ground line to the height of the second branches, or to the height directed, shall be wrapped not later than four (4) days after planting. Trees over 4 inches {100 mm} in caliper shall also have their larger branches wrapped. A single layer of burlap bandage shall be wound spirally starting from the base and overlapping 1.5 inches {38 mm}. The burlap shall be securely tied in place with binder twine at about 6 inches {150 mm} intervals.

c. Method C.

The trunks of all trees from the ground line to the height of the first branches shall be wrapped not later than four (4) days after planting with an approved wrapper, overlapping as noted in Method B.

(f) Pine Straw Mulch.

Mulch shall be baled pine straw. All pine straw shall be fresh and shall be without decomposition. The minimum size of a bale of pine straw shall be 13 inches tall by 14 inches wide by 26 inches long and shall have enough straw to cover a minimum of 40 square feet to a depth of 3 inches. Pine straw shall be free of weeds, weed seeds, spores and fern fronds.

(g) Watering.

The vine, shrub and tree plantings shall be given one watering during the course of the planting operations and additional waterings as needed. Sufficient water shall be applied to wet thoroughly the adjacent area down through the root system. Water shall be applied in such a manner that will prevent erosion of the finished surface.

(h) Care During Construction.

The Contractor shall properly care for all vine, shrub and tree planted areas in a satisfactory condition until the work has been completed, and until final acceptance as defined in Section 105 and other requirements contained in provisions included in the proposal. Care shall consist of providing protection of the planting beds and seedling areas by the use of clearly visible stakes or markers to prevent damage by State maintenance vehicles and/or others. Weeding and repairing of all planted areas or pits, including an area 3 feet {1 m} outside of the normal perimeter of the beds, pits or bedding areas, shall be required with particular attention directed to the following specific times:

1. At the inspection of all planted areas to be made prior to placement of the plants.
2. At the time of Final Inspection.

In addition to the above, any damage to the adjacent areas mentioned above caused by the work involved in the preparing of or by the existence of the beds shall be repaired by the Contractor without cost to the State.

(i) Basis of Acceptance and Replacements.

The Engineer shall make periodic inspections of the work to determine the condition of the plantings. On these inspections, especially those noted in this Section, all plants which the Engineer determines are not in a healthy growing condition shall be rejected. All plants rejected shall be immediately replaced by the Contractor with the same kind and sizes and in the same manner as originally provided except that plantings out of season shall comply with the requirements for out of season plantings noted in Article 860.06.

Not less than 60 or more than 75 calendar days prior to the completion date of the project, an inspection of the plantings shall be made by the Engineer, at which time all defective, dead or missing plants shall be replaced as prescribed for out of season plantings.

Based on the findings of the above noted inspection, the Engineer shall direct the Contractor to replace dead, defective or missing plants; such replacements shall be replaced in the same manner as noted for rejected plants in the paragraph next above.

All replacements, etc., for plants prior to final acceptance shall be considered incidental to the work and no additional compensation other than the unit prices bid will be allowed.

At the final inspection of the project, all dead, defective or missing plants shall be rejected and deleted from the contract and no compensation for rejected plants will be allowed.

660.04 Method of Measurement.

(a) Plant Topsoil.

The accepted quantity of this material used as ordered will be measured in cubic yards {cubic meters} (loose measurement) in the vehicle at point of dumping. No measurement will be made for overhaul of this material.

(b) Vines, Shrubs, and Trees.

The quantity of vines, seedlings, shrubs and/or trees to be paid for under this item will be the actual number ordered, planted and accepted. Only vines, seedlings, shrubs and trees in a living, healthy condition will be accepted.

(c) Pine Straw Mulch.

Pine Straw Mulch will be measured in bales and will be that quantity used on site during planting operations and post planting care. The quantity subject to payment shall be that quantity verified by the Engineer.

660.05 Basis of Payment.

(a) Plant Topsoil.

This material will be paid for at the contract unit price bid per cubic yard {cubic meter} which price and payment will be full compensation for furnishing, excavating, loading, hauling (including overhaul), unloading, furnishing, and mixing all component materials and for all labor, equipment, tools, and incidentals necessary to complete the work.

(b) Vines, Seedlings, Shrubs, and Trees.

Vines, Seedlings, Shrubs, and Trees ordered, planted and accepted will be paid for at the contract unit price for each. Such price and payment shall be full compensation for furnishing plants, plant test or certification service, planting, pruning, guying and staking, wrapping, mulching, furnishing and applying fertilizer (including all fertilizers covered by Article 860.12 and/or provided by the plans), and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

(c) Watering.

No direct payment will be made for water used in the placement and care of planting during the construction. All water necessary shall be considered as a part of the unit price bid for items provided by this Section.

(d) Pine Straw Mulch.

Pine straw mulch will be paid for at the contract unit price which shall be full compensation for furnishing, loading, transporting, applying, and for all labor, tools, equipment, and incidentals necessary to complete this item of work.

(e) Payment will be made under Item No.:

660-A Plant Topsoil - per cubic yard {cubic meter}
660-B Vines, Type - per each
660-C Shrubs, Type - per each
660-D Trees, Type - per each
660-E Seedlings, Type - per each
660-K Pine Straw Mulch – per bale

SECTION 661
TRANSPLANTING TREES, SHRUBS AND VINES

661.01 Description.

This Section shall cover the work of transplanting of specified trees, shrubs and vines and the reestablishing of them in positions shown on the plans or designated.

Basic work consists of digging plants, preparing them for transplanting and transporting thereof; preparation of plant sites or beds, furnishing and preparation of soil fertilizer, mulch and other miscellaneous incidentals necessary to planting procedure; the planting of plants in a workmanlike manner in accordance with accepted horticultural practices along with the water necessary to establish and maintain the plants in a live, growing condition throughout the life of the project. The amount of water to be used and when it is to be applied shall be the Contractor's responsibility until acceptance of the project.

661.02 Materials.

All materials shall conform with the requirements set forth in Division 800, Materials, with specific reference made to Section 860.

661.03 Construction Requirements.

(a) General.

The requirements provided for Vines, Shrubs and Tree Planting, Section 660, and Roadside Improvement Materials, Section 860, shall apply in all respects to transplanting trees and shrubs, except where otherwise indicated by specific requirements given below.

Trees, shrubs and vines to be transplanted will be identified clearly on the plans as to existing and proposed location, species, and size. Planting holes of the size shown on the plans for the particular specie of plant material shall be dug and approved prior to moving existing plants. Material to be transplanted shall be dug with the size ball for collected plants recommended in the American Standard For Nursery Stock, current edition, unless otherwise shown by plan details or directed by the Engineer.

(b) Plant Topsoil

Plant topsoil shall meet the requirements of Section 660.

(c) Watering.

The vine, shrub and tree plantings shall be given one watering during the course of the planting operations and additional watering as needed. Sufficient water shall be applied to wet thoroughly the adjacent area down through the root system. Water shall be applied in such a manner that will prevent erosion of the finished surface.

(d) Care During Construction.

Care during construction shall be the same as specified in Subarticle 660.03(h).

(e) Basis of Acceptance and Replacement.

The basis of acceptance and replacement shall be the same as specified in Subarticle 660.03(i).

661.04 Method of Measurement.

(a) Vines, Shrubs and Trees.

The quantity of transplanted vines, seedlings, shrubs and/or trees to be paid for under this item will be the actual number ordered, planted and accepted. Only vines, seedlings, shrubs and trees in a living, healthy condition will be accepted.

661.05 Basis of Payment.

(a) Vines, Seedlings, Shrubs, and Trees.

Transplanted vines, seedlings, shrubs, and trees ordered, planted and accepted will be paid for at the contract unit price for each. Such price and payment shall be full compensation for furnishing plants, plant test or certification service, planting, pruning, guying and staking, wrapping, mulching, furnishing and applying fertilizer, and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

(b) Watering.

No direct payment will be made for water used in the placement and care of planting during the construction. All water necessary shall be considered as a part of the unit price bid for items provided by this Section.

(c) Payment will be made under Item No.:

661-A Transplanting Vines, Kind - per each
661-B Transplanting Shrubs, Kind - per each
661-C Transplanting Trees, Kind - per each

SECTION 663
TREE WELLS AND TREE ROOT PROTECTION

663.01 Description.

This Section shall cover the work of (1) protecting selected trees, shrubs or other woody plants by the use of tree wells constructed so as to protect the root system and/or (2) placing a porous tree root protection material, mulch or other approved material to such depth around the roots as may be provided by plan details or directed.

Tree wells shall be constructed of concrete, rubble masonry, or brick masonry as may be provided on the plans. Such construction shall be performed in accordance with the design and details indicated on the plans.

663.02 Materials.

All materials furnished for use shall comply with the appropriate requirements of Division 800, Materials, with specific reference to the following:

Tree Well Masonry Concrete, Section 501
Rubble Masonry, Section 612
Brick or Concrete Block Masonry, Section 613
Tree Root Protection Material, Section 860

663.03 Construction Requirements.

(a) Excavation and Drainage.

All excavation incidental to and necessary for constructing the work in the area of the trees to be protected shall be conducted so as to avoid injuring the root system. No backfill of any nature shall be placed by the Contractor above the root spread of a tree or plant designated to be preserved until a porous material not less than 3 inches {75 mm} in depth or the depth directed has first been placed above the roots.

Adequate drainage of tree wells, etc. shall be provided by means of weep holes, drain tile, etc., as may be indicated on the plans or directed.

(b) Tree Wells.

Tree wells shall be constructed in accordance with the dimension and arrangement shown on the plans or as directed. They shall be made of masonry as shown on the plans or directed, provided; however, that mortar will be omitted in any portion of the tree well extending below the level of the top of the contiguous broken stone root protection.

(c) Tree Root Protection.

1. Where tree root protection is ordered, the porous material shall be placed to a depth ranging from 3 to 12 inches {75 to 300 mm} (or to such other depths indicated on the plans) over the root spread of the tree or trees selected, about each of which a tree well is to be constructed, or other trees within or without the fill area, not to be welled but designated for tree root protection.

2. The area for tree root protection shall be first cleaned of all vegetation and porous material shall be then spread loosely over the required area.

3. Following the spreading of the porous material for tree root protection, a minimum of from 4 to 5 inches {100 to 125 mm} of topsoil shall be spread above the porous fill to bring the area to the finished-grade lines designated. Such topsoil shall be transported, handled and paid for under the item of Topsoil, Section 650, all as directed in writing.

4. Sufficient care shall be taken so that trees or shrubs which are to be preserved in place are not scarred or damaged by the operations under this item. The root area to be protected shall be the area of ground surface lying within the periphery of the limb spread of the tree.

663.04 Method of Measurement.

(a) Tree Wells.

The volume of masonry to be paid for shall be the number of cubic yards {cubic meters} of masonry measured complete in place and accepted.

(b) Tree Root Protection.

The volume of tree root protection to be paid for shall be the number of cubic yards {cubic meters} of stone, gravel, slag, or other approved material placed in tree root protection, measured loose in vehicle at point of delivery, and accepted.

663.05 Basis of Payment.

(a) Unit Price Coverage.

The volume of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard {cubic meter} bid for Tree Well Masonry. The volume of porous material tree root protection, measured as provided above, shall be paid for at the contract unit price per cubic yard {cubic meter} for Tree Root Protection Material, which price and payment shall be full compensation for excavating and cleaning the ground surface, for placing the porous fill, for procuring and delivering

all materials and for all labor, equipment, tools and incidentals necessary to complete the item. No direct payment will be made for excavation, including its backfill and disposal, incidental and necessary to tree wells and tree root protection work.

(b) Payment will be made under Item No.:

663-A Tree Well Masonry - per cubic yard {cubic meter}
663-B Tree Root Protection Material - per cubic yard {cubic meter}

SECTION 665
TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

665.01 Description.

This Section shall cover, but not limit, those items of temporary soil erosion and sediment control necessary for the management of construction stormwater discharge quality. The Contractor shall provide and maintain temporary soil erosion and sediment controls designed to protect the project site from soil erosion and adjacent property and waters from damage by sediment transport and deposition during construction. These temporary soil erosion and sediment controls shall be referred to as "Best Management Practices" (BMPs). A BMP is any procedure, process, technique, plan or device that can be utilized to enhance the control of soil erosion and sediment transport.

665.02 Materials.

(a) Temporary Seeding.

Seeds shall be furnished in accordance with the requirements given in Item 860.01(a)1. Seed mixes used for temporary seeding shall be in accordance with the following table:

TEMPORARY SEEDING	
September through December	
Annual Ryegrass	25 pounds per acre {28 kg per hectare}
Kentucky 31 Fescue	30 pounds per acre {34 kg per hectare}
Reseeding Crimson Clover	10 pounds per acre {11 kg per hectare}
January through April 15	
Kentucky 31 Fescue	30 pounds per acre {34 kg per hectare}
Reseeding Crimson Clover	30 pounds per acre {34 kg per hectare}
Annual Ryegrass	15 pounds per acre {18 kg per hectare}
April 16 through August	
Brown Top Millet	30 pounds per acre {34 kg per hectare}
Kentucky 31 Fescue	30 pounds per acre {34 kg per hectare}
Hulled Bermuda Grass	10 pounds per acre {11 kg per hectare}

(b) Temporary Mulching.

Temporary mulching materials shall conform to the requirements given in Article 860.03 for Mulching Material.

(c) Temporary Pipe.

Temporary pipe may be constructed of any type of material that will be suitable for the required work. The inside diameter of the pipe shall be selected by the Contractor based on expected flows and shall be a minimum of 12 inches {300 mm} or as shown on the plans. End treatments, joint sections, and tees shall also be of materials and sizes that are suitable for the required work. Anchors shall be installed when required to keep the pipe in place.

(d) Polyethylene.

Polyethylene sheets may be of any size or color capable of serving the purpose intended provided it is of at least 4 mil {0.1 mm} in thickness.

(e) Temporary Coarse Aggregate.

Temporary coarse aggregate shall be either stone or concrete from the demolition of structures on the Right of Way.

Stone aggregate for stabilized construction entrances and temporary access roads to sedimentation basins shall meet the requirements for ALDOT Number 1 coarse aggregate given in Section 801. Concrete from the demolition of structures shall meet the gradation requirements for ALDOT Number 1 coarse aggregate given in Section 801. Reinforcing steel shall be removed from the concrete used for temporary coarse aggregate.

Stone aggregate for other erosion and sediment control purposes shall be the size shown on the plans and shall meet the requirements given in Section 801.

(f) Temporary Riprap.

Unless shown otherwise on the plans, temporary riprap shall be either stone or concrete from the demolition of structures on the Right of Way. Stone riprap shall meet the requirements for Class 2 riprap given in Section 814. Concrete from the demolition of structures shall meet the size and weight requirements given for Class 2 riprap in Section 814. Reinforcing steel shall be cut flush with the surfaces of the demolished concrete. The geotextile used for both underlayment and as a choker shall meet the requirements of AASHTO M288 for Permanent Erosion Control Geotextile, Class 1. A list of geotextile materials acceptable for use in this application (List II-3 "GEOTEXTILES") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". Choker stone shall meet the requirements of Section 801.

(g) Hay Bales.

Bales may be either hay or straw containing 5 cubic feet {0.14 m^3} of material and having a weight {mass} of not less than 35 pounds {16 kg} with a minimum length of 3 feet {0.9 m}.

(h) Sand Bags.

Bags may be cotton, burlap, woven polypropylene, polyethylene, polyamide fabric or other material that will adequately confine the aggregate content for the duration of the use of the bag. Bags shall be filled with sand, limestone screenings or aggregate that is smaller than ALDOT #78. Fill material shall be selected by the Contractor based on the required bag application. Each filled bag shall have minimum dimensions of 18" x 12" x 3" {450 mm x 305 mm x 75 mm} and shall have a minimum weight {mass} of 30 pounds {13 kg}.

(i) Silt Fence.

Silt fence shall be a geotextile filter supported between metal posts with a woven wire mesh backing as shown on the plans. Posts shall be strong enough to provide and retain the fence configuration shown on the plans while being subjected to loading of silt, water and debris.

Silt fence shall meet the requirements given in Section 810 and AASHTO M 288 as supplemented by the following requirements:

- The minimum fence height shall be 24 inches {61.0 cm} with a T-post weight of at least 1.25 lbs/ft {1.9 kg/m}, and trenches should be offset by 6 in. {15.2 cm}. At the toe of a slope, silt fence(s) should be installed at a minimum distance of 6 ft {1.8 m} to provide an adequate storage volume. For concentrated impoundments, T-post spacing should be reduced to 5 ft {1.5 m} with the incorporation of a dewatering weir. The dewatering weir and all associated items and labor shall be a subsidiary obligation of the silt fence.
- The support backing for the geotextile shall be 14 gage steel woven wire mesh. The vertical spacing of the wire in the mesh shall be 6 {150 mm} inches. The minimum horizontal spacing of the wires shall be 6 inches {150 mm} and the maximum horizontal spacing shall be 12 inches {300 mm}. Geotextile ring fasteners shall have a spacing of 1 ft {0.3 m} on-center, and the filter fabric must be looped over the T-posts.
- The geotextile filter shall be either a non-woven geotextile or a woven geotextile composed of monofilament yarns.

A list of geotextile materials acceptable for use in this application (List II-3 "GEOTEXTILES") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements".

(j) Wattles.

A wattle shall be a tubular shaped product specifically manufactured for erosion and sediment control. Biodegradable wattles shall be manufactured using interwoven biodegradable plant material such as straw, coir, or wood shavings in biodegradable or photodegradable netting that is of sufficient strength to resist damage during handling, installation and use. Wattles manufactured using non-biodegradable materials shall be completely removed from the project when no longer required or useful. Disposal shall be in accordance with recommendations from the wattle manufacturer.

The required minimum diameter of the wattle shall be determined based upon its intended application and shall be as follows unless shown otherwise on the plans. When installed for the purposes of slowing sheet flow or by interrupting the lengths of longer slopes (slopes longer than 50 feet {15 m}), the minimum diameter of the wattle shall be 9 inches {230 mm}. For all other applications including perimeter sediment barriers the minimum diameter of the wattle shall be 20 inches {500 mm}. Wattles of smaller than required diameter may be provided as a stacked installation in accordance with manufacturer recommendations for stacking if the total height of the installation is at least 20 inches {500 mm}. The diameter or height will be verified by measuring the wattle after installation. Wattles installed in a ditch check application shall have a geotextile underlayment that shall meet the requirements of AASHTO M288 for Permanent Erosion Control Geotextile, Class 1. A list of geotextile materials acceptable for use in this application (List II-3 “GEOTEXTILES”) is given in the ALDOT manual titled “Materials, Sources, and Devices with Special Acceptance Requirements”. A geotextile underlayment is not required if the ditch is otherwise lined with materials such as rolled erosion control product, sod, or established permanent vegetation.

A list of acceptable manufactured wattle products (LIST II-24 “TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS”) is given in the ALDOT manual titled “Materials, Sources, and Devices with Special Acceptance Requirements”.

(k) Silt Dikes.

Silt dikes shall be a triangular shaped cross section with a height of at least 8" {200 mm} in the center with equal length sides and a 16" to 20" {400 mm to 500 mm) base. The triangular shape shall be urethane foam. The outer cover shall be a woven geotextile fabric placed around the urethane foam. The geotextile shall also extend beyond both sides of the triangle at least 2 feet {600 mm}. Dikes shall be attached to the ground with wire staples in accordance with the silt dike manufacturer's recommendations.

(l) Brush Barrier.

Brush Barriers shall be constructed of selected brush, limbs and small trees from the clearing operations. The geotextile used for both underlayment and as a choker shall meet the requirements of AASHTO M288 for Permanent Erosion Control Geotextile, Class 1. A list of geotextile materials acceptable for use in this application (LIST II-3 “GEOTEXTILES”) is given in the ALDOT manual titled “Materials, Sources, and Devices with Special Acceptance Requirements”.

(m) Manufactured Inlet Protection Device.

Manufactured Inlet Protection Devices shall be provided in accordance with requirements shown on the plans. Manufactured inlet protection devices shall consist of filter fabric held in place by a rigid frame. The frame shall be strong enough to support the stormwater flow and weight of any sediment that accumulates on the filter. The manufactured inlet protection device shall have an overflow feature to allow the passage of water during high flow conditions. The filter fabric shall have the following properties:

- Minimum Tensile Strength (Machine Direction) of 80 pounds {355 Newtons} (ASTM D 4632);
- Minimum Permittivity of 0.05 sec^{-1} (ASTM D 4491);
- Maximum Apparent Opening Size of US Std #30 sieve {0.60 mm} (ASTM D 4751);
- Minimum UV Stability of 70% (ASTM D 4355 at 500 hours).

A list of acceptable manufactured inlet protection devices (LIST II-24 “TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS”) is given in the ALDOT manual titled “Materials, Sources, and Devices with Special Acceptance Requirements”.

(n) Floating Basin Boom.

Floating basin booms shall consist of a reinforced fabric attached on the upper side to floatation members and ballasted on the lower side with chains or weights to form a bottom-tensioned floating curtain boom. Floating basin booms shall be devices manufactured specifically for use in containing sediment suspended in water.

All materials used in the floating basin boom shall comply with the requirements shown on the plan details and the manufacturer's recommendations for the intended application.

The floatation members shall be made of foam with a minimum diameter of 6 inches {150 mm} or as shown on the plans. The skirt depth below the foam floatation shall be a minimum of 5 feet {1.5 meters} or as shown on the plans. The ballast shall be galvanized proof coil chains or other acceptable weights capable of retaining the skirt in a vertical position. The boom shall be Yellow or International Orange in color.

Anchors capable of holding the floating basin boom in place shall be made of a material recommended by the manufacturer.

(o) Sedimentation Basins.

Components of sedimentation basins shall meet the requirements shown on the plans. Materials for the construction of the sedimentation basins shall be selected from the lists in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" if lists are available for the materials. If lists are not available, materials shall be provided in accordance with all applicable Department specifications and shall be of a quality that enables the sedimentation basin to function as intended for the duration of the need of the sedimentation basin.

The Contractor shall submit a description of all of the materials proposed for the construction of the sedimentation basins. The proposed list of materials shall be submitted with the submittal of the Stormwater Management Plan (SWMP) that is described in Subarticle 108.04(b).

(p) Flow Baffles.

Flow Baffles shall be a rolled erosion control product supported between posts with a wire mesh backing as shown on the plans. The posts and wire mesh shall meet the same requirements as given for silt fence. The rolled erosion control product shall consist of 100 % coconut (coir) fibers and meet the following requirements:

- Minimum Weight of 20 ounces per square yard {678 grams per square meter} (ASTM D 5261);
- Open Area of 50% as determined by physical measurement.

A list of materials acceptable for use in this application (List II-24 "TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements".

(q) Basin Dewatering Devices.

Basin Dewatering Devices shall be a product or structure that withdraws water from the surface of the basin and meets the requirements that are shown on the plans. A list of acceptable basin dewatering devices- (List II-24 "TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements".

665.03 Construction Requirements.

(a) Erosion Control and Runoff Conveyance.

1. Temporary Seeding and Mulching.

a. Inspection to Evaluate Temporary Stabilization.

The project shall be inspected in accordance with the requirements given in Item 107.21(d)2. Areas of the project not undergoing active construction shall be evaluated for temporary stabilization requirements.

b. Temporary Mulching Only.

At locations where final grading should be completed within 60 calendar days, all bare ground shall be stabilized with temporary mulching applied by either hydraulic or conventional methods at a rate of no less than 3.0 tons per acre. Temporary stabilization measures shall be initiated by the end of the next business day, following the day when construction activities will temporarily cease for more than 7 days.

c. Temporary Seeding and Mulching.

At locations where final grading will not be completed within 60 calendar days, all bare ground shall be stabilized with temporary seeding and mulching. Temporary stabilization measures shall be initiated by the end of the next business day, following the day when construction activities will temporarily cease for more than 60 days.

Ground preparation will not be required for temporary seeding and temporary mulching except as follows. Areas to be seeded temporarily shall be left in a rough graded condition. Areas that are smooth or hard shall be lightly scarified with scarifying teeth or some other acceptable method, running perpendicular to the direction of water flow. The intent of this scarifying is to obtain a rough area to hold seed and prevent the formation of rills and gulleys. Areas where sight distances must be maintained shall be bladed smooth. All debris in these areas shall be removed to allow mowing.

Application of 1000 pounds {1120 kg} of 8-8-8 fertilizer per acre {hectare} shall be applied by either hydraulic or conventional methods. Seeding and mulching shall also be applied by either hydraulic or conventional methods at a rate of no less than 2.0 tons per acre, separately or concurrently with fertilizer.

d. Anchoring of Temporary Mulching near Traffic and Streams.

Temporary mulch within 10 feet {3 meters} of traffic or live streams shall be anchored by either crimping, the application of a tackifier adhesive, or the installation of a mulch control netting in accordance with the requirements given in Section 656.

e. Acceptance of Temporary Seeding and Mulching.

Full payment for Temporary Mulching will be made after application of the mulch in accordance with the requirements given in Section 656. Payment for Temporary Seeding will be made in full upon satisfactory application. Acceptance of the Temporary Seeding item requires a cover of living plants capable of effectively preventing soil erosion until such time that permanent soil erosion prevention measures can be installed.

2. Polyethyelene.

Polyethylene sheets shall be placed to eliminate soil erosion on the surfaces of slopes, berms, ditches, and at other locations shown on the plans, accepted SWMP, or as directed by the Engineer. The sheets shall be installed flat and securely anchored to the ground after the ground has been cleared of all objects that may tear the sheets. Upstream sheets shall overlap downstream sheets a minimum of 6 inches {150 mm}. Anchors are considered incidental to this work.

3. Temporary Earth Berms.

Temporary earth berms shall be constructed at the top of cut or fill sections and at other locations where the diversion of water is required. Stream diversion is addressed in Sections 107 and 524. Temporary earth berms shall be constructed at locations shown on the plans, the approved SWMP or as directed by the Engineer. Temporary earth berms may be plated with polyethylene or aggregate. The height of the berms shall be a minimum of 2 feet {600 mm} after compaction. The width of the top of the berm shall be 2 feet {600 mm} with 2:1 side slopes. The construction of berms is encouraged and berms of a very temporary nature may be constructed by the windrowing of material. There will be no direct payment for berms not meeting requirements given in this Section and the requirements shown in the plans. If Pay Item 665-T is not included in the contract, the cost of constructing Temporary Earth Berms will be considered incidental to the grading operation.

4. Temporary Pipe.

Temporary Pipe shall be sized to carry the anticipated volumes of flow and shall be installed as permitted by the Engineer or as shown on the plans. The length shall be as determined by the Engineer. Temporary pipes may be placed without the bedding requirements required for the installation of permanent pipe. Pipes shall be securely anchored. Any required tees or joint sections are considered incidental to the work. End treatments shall be installed in a manner to allow the pipe to function effectively.

5. Stabilized Construction Entrance.

Stabilized construction entrances shall be constructed of materials, at the locations, and to the dimensions shown on the plans, as modified in the accepted SWMP or as directed by the Engineer. The Contractor shall be responsible for maintaining the construction entrance to prevent sediment tracking.

6. Dust Control.

The contractor shall prevent visible dust from leaving the project site by the use of water, dust control agents, or other effective means as approved and directed by the Engineer. Dust control shall be considered ineffective where dust creates a potentially unsafe condition, public nuisance or condition endangering the value, utility or appearance of any property. There will be no direct compensation for dust control.

7. Slope Tracking.

Slope tracking or the surface roughening of slopes shall be accomplished by the walking of tracked equipment upslope and downslope (not along the slope) over the entire erodible area. Slope tracking shall be performed on slopes that are 4:1 or steeper and longer than 20 feet. Slope tracking shall be performed immediately after the final shaping of the slope.

(b) Sediment Control.

1. Placement of Sediment Control BMPs in Streams.

Sediment control BMPs shall not be placed in a live stream for the purpose of capturing upland sediment. Additionally, no live stream shall be dammed or ponded for the purpose of water access and usage. Secondary sediment control BMPs in the form of Floating Basin Booms may be placed in live streams parallel to the flow along the bank only as shown in the plans or at the direction of the Engineer.

2. Ditch Checks.

Ditch checks shall be constructed at locations shown on the plans, the accepted SWMP or as directed by the Engineer. Materials and products used to construct ditch checks may include sand bags, hay bales, wattles with geotextile, silt fence, silt dikes, or rock with geotextile. The materials used shall be installed in accordance with the requirements given in this Section, the requirements shown on the plans and the manufacturer's recommendations for manufactured products.

3. Sediment Barriers.

Sediment barriers shall be constructed at the locations shown on the plans, the accepted SWMP or where directed by the Engineer to intercept sheet flow runoff and to treat concrete washout wastewater. Sediment barriers utilized for sediment control adjacent to the construction limits or a live steam shall be installed prior to beginning any grubbing work in the contributing drainage area. Types of sediment barrier may include silt fence, hay bales, sand bags, silt dikes or wattles. The materials used shall be installed in accordance with the requirements given in this Section, the requirements shown on the plans and the manufacturer's recommendations for manufactured products.

4. Brush Barriers.

Brush barriers shall be constructed at the locations shown on the plans, the approved SWMP or where directed or permitted by the Engineer. Brush barriers may be constructed in rural areas where natural ground is sloping away from the project. Brush barriers shall be compacted to a relatively dense barrier with uniform heights of between 3 and 5 feet and base widths of between 5 and 10 feet {between 1.5 m and 3.0 m} perpendicular to the flow. Geotextile underlayment and geotextile choker shall be securely attached to the faces of brush barriers. These barriers shall be removed when no longer needed unless otherwise directed by the Engineer.

5. Inlet Protection.

Inlet protection shall be installed at locations and in accordance with requirements shown on the plans for the appropriate stages of construction or as directed by the Engineer. Approved manufactured products shall be installed as per manufacturer's recommendations. Site constructed protection may include wattles, silt fence, sand bags, drainage sumps or other practices shown on the plans or directed by the Engineer. In no case will in-structure protection be allowed.

Stage 1 Inlet Protection shall be installed after the outflow drainage has been installed and prior to the construction of the inlet. Stage 1 Inlet Protection shall be ditch checks and/or sediment barriers and shall allow sufficient access to continue inlet construction.

Stage 2 Inlet Protection shall be installed after the inlet is constructed and prior to backfilling. Stage 2 Inlet Protection shall be a sediment barrier. Hay bales are not acceptable for use during this stage of inlet construction.

Stage 3 Protection is required after inlets are completed through grate installation and prior to complete stabilization of the area surrounding the inlet. Stage 3 Inlet Protection for drop inlets shall be in accordance with requirements and details shown on the plans. Stage 3 Inlet Protection shall be a manufactured inlet protection device or constructed with coarse aggregate, wattles or sand bags. Hay bales are not acceptable for use during this stage of inlet construction.

Stage 4 Inlet Protection for drop inlets shall be in accordance with requirements shown on the plans. Stage 4 Inlet Protection shall be a manufactured inlet protection device or constructed with hay bales, wattles or sandbags stacked at least three bags high. Hay bales, sand bags and wattles shall be used as a barrier along the perimeter of the slope paved apron as shown on the plans for a minimum distance of 20 feet {6.1 m}. If impervious surfaces extend beyond 20 feet {6.1 m}, sand bags shall be used as a barrier across the surface 20 feet {6.1 m} from the inlet. Stage 4 Protection will only be required where there is surrounding impervious surfaces that may receive sediment laden runoff.

All inlet protection installations shall be constructed to ensure that runoff does not bypass the inlet. Components of inlet protection may be reused on future installations provided the condition meets the material requirements given in this Section.

6. Outlet Protection.

Outlet protection required by the plans or directed by the Engineer shall be installed in accordance with the details shown on the plans as soon as practicable after the completion of the drainage structures.

7. Drainage Sumps.

Temporary drainage sumps shall be constructed as shown on the plans and in locations directed or permitted by the Engineer using the Erosion and Sediment Control Plan (ESCP) as guidance for the location. In general, the shape should be rectangular at the surface with the longer dimension parallel to the flow of water. The minimum volume shall be that shown on the plans. Sumps may be constructed with larger volumes as directed and permitted by the Engineer.

Construction of the sumps shall be accomplished by methods and equipment suitable for the purpose and acceptable to the Engineer. The sump may be supplemented by the use of a ditch check, temporary pipe, polyethylene or other temporary items shown on the plans or approved by the Engineer.

When the sump is deemed of no further use, it shall be backfilled with suitable material and compacted as directed and the area dressed and shaped to blend with the adjacent natural ground.

8. Sedimentation Basins.

Sedimentation basins shall be constructed in accordance with the details shown on the plans and at the locations shown on the plans or as directed by the Engineer. Sedimentation basins shall be constructed prior to beginning grading operations in the contributing drainage area. Where sedimentation basins are to be constructed in locations where permanent ditches are required, the required ditch lines and grades shall be utilized for the construction of the sedimentation basins. During removal of the sedimentation basin, aggregate used to construct the sedimentation basin may remain in the ditch as a permanent lining. Sedimentation basins are designed to allow the removal of sediment and turbidity from stormwater runoff by the flocculation and settlement of suspended particles. The removal of sediment and turbidity shall be accomplished by the retention of stormwater runoff in the basin for a period of time before completely draining. In no case shall sediment be allowed to exceed one third of the height of the forebay or drainage sump adjacent to the inlet of the basin.

Access roads to facilitate maintenance efforts shall be constructed of materials, at the locations, and to the dimensions shown on the plans, as modified in the accepted SWMP or as directed by the Engineer. The Contractor shall be responsible for maintaining the access road until directed by the Engineer to perform basin removal or retrofit. The Contractor shall take care during removal of accumulated sediment to not puncture the basin liner. The Contractor shall also take care during removal or retrofit of the sedimentation basin to not excavate past the original basin bottom elevation unless otherwise directed by the Engineer.

9. Flow Baffles.

Flow Baffles shall be installed in sedimentation basins or ditch applications as required by the plans to reduce the velocity of stormwater runoff. They shall be installed in accordance with the details shown on the plans.

10. Basin Dewatering Devices.

Basin Dewatering Devices shall be installed in sedimentation basins in accordance with the details shown on the plans. Each device shall be capable of dewatering the full capacity of the basin over a period of 72 hours unless otherwise specified in the plans. Each device shall have a shutoff valve on the outlet pipe that should remain closed until discharges meet state water quality standards and the requirements of the ADEM NPDES General Permit.

11. Floating Basin Booms.

Floating basin booms shall be installed only for secondary sediment containment or to prevent the migration of sediment within a water body. Floating Basin Booms shall be installed at the locations shown on the plans, the accepted SWMP or as directed by the Engineer. Installation shall be as shown on the plans and as recommended by the manufacturer. Basin Booms shall not be installed in locations where they will not be effective or in conditions where continuous maintenance is not practical.

(c) Maintenance and Removal Requirements.

The Contractor shall be responsible for daily inspection, daily preventative maintenance and immediate repairs of all temporary soil erosion and sediment control items. The Contractor shall maintain on-site, or have readily available, sufficient erosion and sediment control devices and materials to perform maintenance, repairs, and prepare the site for impending rain events. All BMPs which capture sediment shall be cleaned by the removal and disposal of sediment when the holding capacity reaches one third full and when necessary for the BMP to remain functional. Any offsite sediment loss shall be removed as directed by the Engineer. Any offsite tracking of sediment onto public roadways shall be removed by the end of the same business day, and construction entrances shall be stabilized as needed. Sediment removed during the maintenance of BMPs or collected from off-site cleanup should be reincorporated into the site or disposed of as approved by the Engineer.

All temporary soil erosion and sediment control BMPs shall be removed from the project when no longer needed unless shown otherwise on the plans, the accepted SWMP, or directed or permitted by the Engineer. Removal of temporary controls shall be only after permanent controls are in place and functioning properly. The removal of all controls shall be followed by the immediate stabilization of the area as directed by the Engineer.

665.04 Method of Measurement.

(a) Temporary Seeding.

Temporary Seeding (Item 665-A) will be measured in acres {hectares} computed from surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 of an acre {0.01 ha}.

(b) Temporary Mulching.

Temporary Mulching (Item 665-B) will be measured in units of tons {metric tons}. Proof of material weight shall be provided to the Engineer by the Contractor upon delivery of the materials to the project site. The weight ticket shall contain all items required in Subarticle 109.01(h)2. with the exception of the name of the producer and the truck number.

(c) Temporary Pipe.

Temporary Pipe (Item 665-C) will be measured in linear feet {meters} to the nearest foot {0.1 m} with measurements taken along the center line of the pipe.

(d) Polyethylene.

Polyethylene sheets (Item 665-E) will be measured in square yards {square meters} computed from surface measurements of the area treated. Computations will be to the nearest 0.1 square yard {0.1 square meter}.

(e) Temporary Earth Berms.

Temporary Earth Berms (Item 665-T) will be measured in linear feet {meters} to the nearest foot {0.1 meter} with measurements taken along the top of the berm. Aggregate or polyethylene protection will be paid separately if directed or permitted by the Engineer. There will be no direct payment for berms not meeting requirements given in this Section or shown in the plans.

(f) Temporary Coarse Aggregate.

Temporary Coarse Aggregate (Item 665-N) will be measured in units of tons {metric tons}.

(g) Temporary Riprap.

Temporary Riprap (Item 665-I) will be measured in units of tons {metric tons}. Geotextile installed both as underlayment and as a choker for riprap ditch checks shall be measured separately and payment made in accordance with the requirements given in Section 610. If provided in the plans, stone used for choking shall be measured separately and paid in accordance with the appropriate pay item.

(h) Hay Bales.

Hay Bales (Item 665-F) will be measured per each bale unless used in Stage 4 Inlet Protection.

(i) Sand Bags.

Sand Bags (Item 665-G) will be measured per each bag unless used in Stage 3 or 4 Inlet Protection.

(j) Silt Fence and Silt Fence Removal.

Silt Fence (Item 665-J) and Silt Fence Removal (Item 665-O) will be measured along the top of the fence fabric in linear feet {meters} to the nearest foot {0.1 m}.

(k) Wattles.

Wattles (Item 665-Q) will be measured after installation in linear feet {meters} to the nearest 0.1 foot {0.01 meter} with measurements taken along the top of the wattle installation unless used in Stage 3 or 4 Inlet Protection. Wattles installed as sediment barriers or ditch checks shall have a diameter of 20 inches {500 mm} verified by measurement of the circumference anywhere along the length of the wattle which shall be at least 56 inches {1.42 m}. Payment for stacked wattles will be made at the contract price for a single 20 inch {500 mm} diameter wattle. Wattles installed as slope interrupters shall have a diameter of 9 inches {230 mm} verified by measurement of the circumference anywhere along the length of the wattle which shall be at least 25 inches {0.64 m}. Field measurements will be used to verify lengths shown on shipping documentation. The lesser of the two lengths will be used for payment. Geotextile installed as underlayment for wattle ditch checks shall be measured separately and payment made in accordance with the requirements given in Section 610.

(l) Silt Dikes.

Silt Dikes (Item 665-R) will be measured in linear feet {meters} to the nearest 0.1 foot {0.01 meter} with measurements taken along the top of the dike.

(m) Brush Barriers.

Brush Barriers (Item 665-S) will be measured in linear feet {meters} to the nearest foot {0.1 meter} with measurements taken along the top of the barrier. Geotextile installed both as underlayment and as a choker will be measured separately and payment made in accordance with the requirements given in Section 610.

(n) Inlet Protection.

Materials used to construct Stage 1 and 2 Inlet Protection will be measured for payment as appropriate for items such as silt fence, wattles, hay bales, etc. This also applies to curb inlet protection necessary beyond Stage 2.

Stages 3 and 4 Inlet Protection (Item 665-P) for drop inlets will be measured per each stage of each inlet protected if protected in accordance with the details shown on the plans.

(o) Drainage Sump Excavation.

Drainage Sump Excavation (Item 665-K) will be measured in cubic yards {cubic meters} computed from dimensions of the sump size and depth approved by the Engineer. Material removed during sump maintenance operations will be measured for payment as Drainage Sump Excavation to the nearest cubic yard {0.1 cubic meter}. No measurement will be made for material used as backfill when the sump is closed.

Removal of sediment collected by sedimentation basins, sediment retention barriers, ditch checks and inlet protection will be measured as drainage sump excavation if soil erosion is being prevented to the maximum extent practicable.

If the proposal does not contain this item, measurement and payment will be made under the Item of Unclassified Excavation. Material removed will not be paid as muck excavation regardless of the consistency.

(p) Sedimentation Basins.

Each component and work item required for the construction of a Sedimentation Basin will be measured individually for payment. Excavation and embankment will be measured as Unclassified Excavation. Removal of captured sediment will be measured as Drainage Sump Excavation. Typical items required to construct the sedimentation basin may include unclassified excavation, aggregates, riprap, filter fabric, polyethylene, flow baffles, rolled erosion control products, seeding, basin dewatering device, temporary pipe, etc. Access roads to sedimentation basins, as shown in the plans or as directed by the Engineer, will be measured separately and payment made as Temporary Coarse Aggregate (Item 665-N) and geotextile in accordance with the requirements given in Section 610, unless otherwise specified in the plans. No measurement will be made for access roads installed without the approval of the Engineer.

(q) Flow Baffles.

Flow Baffles (Item 665-H) will be measured along the top of the baffle material in linear feet {meters} to the nearest foot {0.1 m}.

(r) Basin Dewatering Devices.

Basin Dewatering Devices (Item 665-X) will be measured per each. Elevated device rest, outlet pipes, valves, and end treatments serving the basin dewatering device are considered to be a part of the device and will not be measured separately for payment.

(s) Temporary Pipe End Treatments.

Temporary Pipe End Treatments (Item 665-D) will be measured per each.

(t) Floating Basin Booms.

Floating Basin Booms (Item 665-L) will be measured in linear feet {meters} to the nearest 0.1 foot {0.01 meter} with measurements taken along the top line of the boom.

665.05 Basis of Payment.

(a) Unit Price Coverage.

The unit price for all temporary erosion and sediment control items, except drainage sumps and silt fence, shall be full compensation for furnishing all materials unless otherwise noted, the construction and installation of the materials into complete erosion or sediment control measures, and shall include all equipment, tools, labor and incidentals necessary to complete the work, to perform maintenance to keep work in an acceptable condition, and to remove the items when no longer needed as directed by the Engineer. The excavation of sediment collected by drainage sumps, ditch checks, sediment barriers and other sediment control BMPs will be considered for payment as Drainage Sump Excavation as long as erosion is being controlled to the maximum extent practicable. Direct payment will be made for the removal of silt fence.

Payment for Stage 3 and Stage 4 Inlet Protection shall include the installation and maintenance of all items at quantities shown on the plans as being required or permitted.

Payment for sedimentation basins will be made for individual components and work items required for construction and shall be full compensation for the installation, maintenance and removal of all components of the sedimentation basin as constructed in accordance with requirements shown on the plans. Payment for access roads to sedimentation basins will be made for individual components required for the construction and shall be full compensation for the installation, maintenance and removal when no longer needed as directed by the Engineer.

In the event that additional temporary or permanent erosion and sediment control measures become necessary due to the negligence or actions of the Contractor, or for the contractor’s convenience the temporary work shall be performed at the Contractor's expense. Temporary or permanent erosion control measures installed in previously stabilized areas that are necessary due to required work sequencing will be paid as outlined in this section.

Payment will not be made for any temporary erosion or sediment control measures installed due to the methods chosen by the Contractor to perform the required work. Measures include those utilized for convenience, for access to the work (work bridges or platforms, stream crossings, access roads, haul roads), those utilized for treating or handling water in order to assist the Contractor in the execution of the work (diversions, dewatering, conveyances) or those utilized for protecting the Contractor's work or staging areas. Payment will also not be made for measures installed outside of the right of way or easements such as material pits, haul or access roads, plant sites, and staging areas.

(b) Payment will be made under Item No.:

665-A Temporary Seeding - per acre {hectare}
665-B Temporary Mulching - per ton {metric ton}
665-C Temporary Pipe - per linear foot {meter}
665-D Temporary Pipe End Treatment – per each
665-E Polyethylene - per square yard {square meter}
665-F Hay Bales - per each
665-G Sand Bags - per each
665-H Flow Baffle – per linear foot {meter}
665-I Temporary Riprap, Class ____ - per ton {metric ton}
665-J Silt Fence - per linear foot {meter}
665-K Drainage Sump Excavation - per cubic yard {cubic meter}
665-L Floating Basin Boom - per linear foot {meter}
665-N Temporary Coarse Aggregate, ALDOT Number ____ - per ton {metric ton}
665-O Silt Fence Removal - per linear foot {meter}
665-P Inlet Protection, Stage 3 or 4 – per each

665-Q Wattle - per linear foot {meter}
665-R Silt Dike - per linear foot {meter}
665-S Brush Barrier - per linear foot {meter}
665-T Temporary Earth Berm - per linear foot {meter}
665-X Basin Dewatering Device – per each

SECTION 666
PEST CONTROL

666.01 Description.

The work covered by this Section shall consist of furnishing and applying designated chemicals to control certain destructive pests, namely, Armyworm, Fall Armyworm, Cutworm, Spittlebug, White Grubs and Pine Bark Beetles.

Because of the destructive nature of the action of these pests to trees and ground cover with the possible result of erosion and ultimate siltation of areas, control of these pests is a necessity.

Both the Engineer and the Contractor have the responsibility of continually observing the planted areas for possible pest damage. The Contractor should, upon observing any of these pests, report such to the Engineer, both verbally and in writing.

The Engineer will verify any reports of this type of pest and direct appropriate treatment to be taken.

The following brief descriptions are provided for ease in recognizing these pests:

Armyworm: A medium size caterpillar of dark green color with white stripes on sides and down the middle of the back, Size, approximately 1 inch {25 mm} in length. This worm usually feeds only at night destroying foliage.

Fall Armyworm: A medium size caterpillar of dark green color with white stripes on sides and down the middle of the back with a distinctive yellow inverted "Y" on the head capsule. Size, approximately 1 inch {25 mm}. This worm will feed both day and night destroying foliage.

Cutworm: A fat bodied caterpillar with a greasy appearance, color mostly greybrown or mottled on top and lighter color underneath. Size, approximately 1 to 2 inches {25 to 50 mm} in length when full grown. This worm hides during the day and feeds at night, destroying foliage.

Spittlebug: Most easily identified by a frothy mass of plant juice at the forks of plant stems resembling spittle. This pest lives inside the spittle mass.

White Grubs: The immature (larval) stage of June or May beetles. Length, 0.5 to 1.5 inches {13 to 38 mm}, have three pairs of legs near the head, and characteristically rest in a C-shaped position. Their heads and rear ends are brown. Green June Beetle grubs crawl on their backs with their legs up.

Pine Bark Beetles: These beetles are distinguished from other bark beetles in that the rearward end of the abdomen is scooped out and spined (4 to 6 spines on each side). The southern pine beetle and black turpentine beetle have a more rounded abdomen. The black turpentine beetle is the larger of the two, being about 1/4 inch {6 mm} long . The southern pine beetle is about 1/8 {3mm} inch long. All of the pine bark beetles are roughly cylindrical and are dark brown to black.

666.02 Material.

The treatments to be used under this Section shall be as per the current Alabama Pesticide Handbook or Guidelines as may be issued by the Alabama Cooperative Extension Service. As new pesticide materials are approved by the State Department of Agriculture and Industries, the Bureau of Construction may allow their use upon written request by the Contractor.

All chemicals shall be a product of a reputable manufacturer, processed in accordance with all State and Federal regulations for such manufacture.

Restricted Use of Insecticides

Whenever the State Department of Agriculture and Industries or other Federal or State agency restricts the use of any insecticide on highway right-of-way, its initial or continued use shall require the approval of the Construction Engineer. It is illegal to place herbicides in a manner that is not consistent with the requirements shown on the insecticide container labeling.

666.03 Construction Requirements.

(a) General.

The Engineer after verification of the pest occurrence and identification of the type pest shall direct the use of treatments as noted in Article 666.02 in accordance with the following:

Equipment used in the application shall be designed for the application method to be used and approved by the Engineer for use.

The application of pesticides shall be performed by or under the direct supervision of a licensed pesticide applicator, licensed in the area of right-of-way pest control. Uniform coverage is required. If uniform coverage is not obtained, the Contractor shall retreat the entire area in such a manner that uniform coverage is obtained. Retreatment because of uneven coverage shall be without additional cost to the State. Retreatment shall not be performed within seven days of the original treatment. All treatments shall be at the direction of the Engineer.

In all treatments, dilutions of liquids and technical material dosage applied shall follow label instructions, these Specifications and be verified by the Engineer.

Any change to the dilution rates of a specific chemical or the substitution of chemicals other than those meeting the requirements of Article 666.02 must have prior written approval of the Construction Engineer and any such approved change must be without additional cost to the State.

(b) Safeguards.

Safeguards in applying insecticides are the responsibility of the Contractor, and he shall be responsible for any damage to humans or wildlife incurred during application operations.

The following are minimum basic safeguards to be observed.

1. Avoid drift of any spray or dust material on adjacent property.
2. Confine Sprays or Dust to areas that will not contaminate streams or lakes adjacent to the Right-of-Way.
3. Carbaryl (Sevin) and Malathion are highly toxic to bees; therefore, if spraying or dusting is carried out near bee yards, give advance notice to beekeeper so that he can protect his bees.
4. In general, spraying with ground equipment is the least hazardous to wildlife; therefore, all treatment shall be applied by approved ground driven equipment unless approved otherwise by the Engineer.
5. Operators of spraying or dusting equipment must wear the recommended apparel for specific insecticides being applied in executing this work.
6. Only qualified personnel will be permitted to engage in this type operation. The Contractor or subcontractor shall submit, if required by the Alabama Department of Transportation, a list of the roads, railroads, or other areas that he has treated. This list must be certified by the official for whom the work was performed.
7. Normally, pesticide spraying will be restricted to roadside areas which are under construction, and subsequently, are not open to the public. However, should areas such as scenic overlooks, rest areas, etc., be ordered treated, precautions for the protection of the public must be taken; namely, by keeping pedestrians off the area until the insecticide dissipates from the turf area to a point that it is no longer an area of concern in accordance with the product labeling.

666.04 Method of Measurement.

Item 666-A will be measured in acres {hectares} computed from surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 of an acre {0.1 ha}.

Item 666-B will be measured by the gallon {liter} of dispensed solution with measurements taken from the storage vessel before and following dispersal to determine the actual amount of solution used. Computations will be to the nearest gallon {L}.

Item 666-C will be measured by the square yard {square meter} of dispensed solution with surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 square yard {0.1 square meter}.

666.05 Basis of Payment.

(a) Unit Price Coverage.

Completed and accepted pest control treatment measured as noted above shall be full compensation for the furnishing of the respective insecticide noted, for the uniform application of the

insecticide and for all materials, equipment, tools, labor and incidentals necessary for the satisfactory completion of the work.

(b) Payment will be made under Item No.:

666-A Pest Control Treatment- per acre {ha}
666-B Spot Pest Control Treatment - (*) (**) (***) (****) per gallon {L}
666-C Spot Pest Control Treatment - (*) (**) (***) (****) per square yard {square meter}

* Specify Type
** Specify Rate
*** Specify Carrier Rate of Application
**** Specify Type of Carrier

SECTION 668
PRE-EMERGENT HERBICIDE TREATMENT

668.01 Description.

This section shall cover the work of applying soil active herbicide(s) on the highway right-of-way in accordance with the plans, specifications, material label instructions, or as directed by the Engineer to control the growth of noxious weeds, brush, vines and grasses.

668.02 Materials.

Materials furnished for use in this vegetation control work shall be produced by reputable, recognized manufacturers and registered by the U.S. Environmental Protection Agency. Materials shall be licensed for use in the State of Alabama and shall be pre-qualified for use by the Alabama Department of Transportation. An approved drift control agent shall be used in all liquid broadcast applications. Adjuvants, such as, but not limited to, surfactants shall be used when called for by product label instructions of the herbicide designated on the plans or directed by the Engineer. All herbicide and related adjuvants shall be labeled for right-of-way use. Unless specified otherwise by the plans and/or proposal, potable water shall be the carrier for dispersing the herbicide. The use of herbicides other than those dispensed with a water carrier, such as granules, pellets, powders, capsules, etc., shall be placed as indicated on the product label at locations indicated on the plans, or as directed by the Engineer. Herbicides and their application rates that are approved for use on ALDOT rights-of-way may be found in the latest edition of the Addendum to "A Manual for Roadside Vegetation Management – Chapter IV" which is revised, printed and distributed annually by the Alabama Department of Transportation's Maintenance Bureau. The type of herbicide required on the project and the required application rate will be shown on the Plans.

668.03 Construction Requirements.

(a) Equipment.

1. Equipment for Broadcast Spraying.

The Contractor shall utilize equipment in this contract that is in good working condition and is suitable and safe for accurately dispensing herbicide within the right-of-way limits of the highway and for performing the work required under this contract. The contractor shall provide sufficient equipment and accessory items necessary for efficient operation and completion of the herbicide application in the designated time limitations.

Broadcast spraying equipment shall be capable of controlling the rate of application using a computerized, calibrated sprayer. The computer module and accessory equipment shall be capable of monitoring ground speed with the ability to compensate the output volume of the spray solution to provide accurate and uniform dispensing of the spray solution to the surface area of the highway right-of-way throughout the operable speed range. The computer shall have a non-volatile memory with the ability to store and report data. Reporting capability shall include quantity of material sprayed, area treated, and hours of operation on a daily basis.

Equipment shall be capable of dispensing herbicide by either (1) tank mixed solution, or (2) chemical injection and mixing immediately prior to the distribution nozzles. In the event tank mix equipment is used, means shall be provided for constant agitation (either jet or mechanical) of the mixture during the filling and spraying operation. Each piece of equipment shall be equipped with a

hand gun and nozzles capable of spreading the mixed solution uniformly, at the specified rate, over surface areas missed or inaccessible to the broadcast spraying.

Herbicide application equipment operated from the roadway or paved shoulder surface shall be equipped with a portable sequential arrow unit and impact attenuator or be immediately followed at all times by a shadow vehicle equipped with these two items.

Smaller motorized ground operated equipment may be used with the approval of the Engineer. This equipment may be used on smaller areas, such as landscaped areas within the limits of the right-of-way. The smaller areas are defined as the areas that are inaccessable to truck mounted and agricultural type sprayers normally used for broadcast applications from the roadway or open areas within the right-of-way. This smaller motorized ground operated equipment shall be equipped with a hand gun and/or nozzles capable of spreading the mixed solution uniformly over the area to be treated. Means shall be provided for constant agitation (either jet or mechanical) of the mixture during the filling and spraying operations.

2. Equipment for Spot Spraying.

Spot spraying by means of hand guns, backpack sprayers, portable tanks, etc., shall be capable of applying the herbicide solution at the designated plan rate or as directed by the Engineer. Herbicides placed with this type equipment shall dispense solution which contains the correct herbicide to carrier ratio. The herbicide solution shall be directed and placed on the target area to provide uniform, adequate and proper coverage.

(b) Methods of Operation.

Prior to beginning work, a conference between representatives of the Department and the Contractor will be arranged by the Department. In this meeting plans, specifications, unusual conditions, methods for marking non-sprayable areas, and other pertinent items regarding the work will be discussed. Certain "No-Spray" areas may occur; these fall within the defined limits of the spraying area as indicated by the plans and specifications. These areas are where various businesses or agencies have ornamental plantings or improved turf within the highway right-of-way and perform their own maintenance, or as directed by the Engineer. The Department will determine all non-sprayable areas.

Spraying will not be permitted when, in the opinion of the Engineer, soil, vegetation, and/or weather conditions are such that the right-of-way or the vegetation would be damaged or spraying would be ineffective.

The Contractor shall spray as close as practicable to all fixed objects, exercising extreme care not to damage trees, plants, shrubs, signs, delineators or other appurtenances which are part of the facility. Any damage caused by the Contractor's spraying operations to any tree, plant, shrub, sign, delineator or other appurtenance which is part of the facility shall be pruned, trimmed, repaired or replaced immediately by the Contractor at no cost to the Department. The Engineer will determine whether the damage shall be corrected by pruning, trimming, repair or replacement.

The Contractor shall be responsible for any damage to public or private property which may occur as a result of the spraying operation.

(c) Spraying Application Requirements.

The Contractor shall possess the appropriate license and permit required by the State of Alabama Department of Agriculture and Industries for conducting business in the State of Alabama.

All personnel directly involved in the application of the herbicide solution, to include operators and project supervisory personnel, shall be experienced in the ground application of pesticides on highway rights-of-way.

Operators and project supervisors involved with this project shall possess a commercial applicator permit issued by the State of Alabama Department of Agriculture and Industries covering the "Right-of-Way" category.

The Contractor will furnish two copies of product labels and material safety data sheets for the products used on the project. One copy of each will be furnished to the Engineer and one copy will be kept with the vehicles applying the herbicide at all times.

While spraying, care shall be exercised to prevent damage by spray drift or direct contact of herbicide to areas containing plantings of shrubs and bushes, designated wildflower areas, deciduous or evergreen trees, residential plantings, vegetable or flower gardens, any susceptible farm crops, or other desirable plants. In the event of damage to any desirable plants which includes damage or "brown-out" to low hanging limbs of trees along the right-of-way, the Contractor will correct by either replacement, pruning, trimming or compensation of any damages caused by the misapplication or drift

of the herbicide solution immediately following visual recognition, verbal or written notification and/or instructions from the Engineer.

No herbicide solution shall be sprayed without a drift control agent. No spraying shall be undertaken when the wind velocity is 5 mph {8 km/h} or greater.

No spraying shall be undertaken during a rain, when heavy rain is imminent, or when soil is saturated.

The Contractor shall take extreme care to insure that herbicide does not enter any lakes, streams, ponds or wetlands.

The speed of any vehicle used to apply the herbicide solution to the highway right-of-way, shall not exceed 11 mph {18 km/h} when operated from the roadway/paved shoulder surface or 5 mph {8 km/h} when operated off the improved portion of the roadway.

The pattern of spray shall be such as to provide even, uniform coverage.

(d) Liability of Contractor.

The Contractor shall assume all liability for any damage resulting from the application of the herbicides for this project and shall hold the State of Alabama harmless from any claims arising from this damage. It is illegal to place herbicides in a manner that is not consistent with the requirements shown on the herbicide container labeling.

(e) Record of Work.

It shall be the Contractor's responsibility to "scout ahead" for each day's anticipated work. Department-furnished forms (BM-196) "Herbicide Scouting Report" shall be completed prior to the beginning of each day's work. A completed and signed copy shall be furnished to the Department's Engineer for each day's operation.

The Contractor shall account for each day's work and provide information on location, area covered, weather conditions, personnel, equipment, herbicide used, rates and productivity. This information shall be provided on the Department's "Herbicide Treatment Report", which will be provided by the Department. A completed and signed copy of this report shall also be furnished to the Department's Engineer for each day's work.

668.04 Method of Measurement.

Item 668-A will be measured in acres {hectares} computed from surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 of an acre {0.1 ha}.

Item 668-B will be measured by the gallon {L} of dispensed solution with measurements taken from the storage vessel before and following dispersal to determine the actual amount of solution used. Computations will be to the nearest gallon {L}.

Item 668-C will be measured by the square yard {square meter} of dispensed solution with surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 square yard {0.1 square meter}.

668.05 Basis of Payment.

(a) Unit Price Coverage.

Payment for all satisfactorily completed work of pre-emergent herbicide application as specified, measured as provided above, will be paid for at the contract bid price which shall be full compensation for furnishing all labor, equipment, herbicides, adjuvants, carrier, fuels, incidentals and liability insurance necessary to complete the work. Partial payments will be made on monthly estimates based on the percentage of the total work performed as estimated by the Engineer.

(b) Payment will be made under Item No.:

668-A Broadcast Pre-Emergent Herbicide Treatment (*) (**) (***) (****) per acre (ha)
668-B Spot Pre-Emergent Herbicide Treatment (*) (**) (***) (****) per gallon {L}
668-C Spot Pre-Emergent Herbicide Treatment (*) (**) (***) (****) per square yard {square meter}

* Specify Type of Herbicide
** Specify Rate of Herbicide Application
*** Specify Carrier Rate of Application
**** Specify Type of Carrier

SECTION 669
POST-EMERGENT HERBICIDE TREATMENT

669.01 Description

This section shall cover the work of applying contact (foliage active) herbicide(s) on the highway right-of-way in accordance with the plans, specifications, material label instructions or as directed by the Engineer to control the growth of noxious weeds, brush, vines and grasses.

669.02 Materials

Materials furnished for use in this vegetation control work shall be produced by reputable, recognized manufacturers and registered by the U.S. Environmental Protection Agency. Materials shall be licensed for use in the State of Alabama and pre-qualified for use by the Alabama Department of Transportation. An approved drift control agent shall be used in all liquid broadcast applications. Adjuvants, such as, but not limited to, surfactants shall be used when called for by product label instructions of the herbicide designated on the plans or directed by the Engineer. All herbicide and related adjuvants shall be labeled for right-of-way use. Unless specified otherwise by the plans and/or proposal, potable water shall be the carrier for dispersing the herbicide. The use of herbicides other than those dispensed with a water carrier, such as herbicides dispensed with oil shall be placed as indicated on the product label at locations indicated on the plans, or as directed by the Engineer. Herbicides and their application rates that are approved for use on ALDOT rights-of-way may be found in the latest edition of the Addendum to "A Manual for Roadside Vegetation Management – Chapter IV" which is revised, printed and distributed annually by the Alabama Department of Transportation's Maintenance Bureau. The type of herbicide and the required application rate will be shown on the plans.

669.03 Construction Equipment

(a) Equipment

1. Equipment for Broadcast Spraying.

The Contractor shall utilize equipment in this contract that is in good working condition and is suitable and safe for accurately dispensing herbicide within the right-of-way limits of the highway and for performing the work required under this contract. The contractor shall provide sufficient equipment and accessory items necessary for efficient operation and completion of the herbicide application in the designated time limitations.

Broadcast spraying equipment shall be capable of controlling the rate of application using a computerized, calibrated sprayer. The computer module and accessory equipment shall be capable of monitoring ground speed with the ability to compensate the output volume of the spray solution to provide accurate and uniform dispensing of the spray solution to the surface area of the highway right-of-way throughout the operable speed range. The computer shall have a non-volatile memory with the ability to store and report data. Reporting capability shall include quantity of material sprayed, area treated, and hours of operation on a daily basis.

Equipment shall be capable of dispensing herbicide by either (1) tank mixed solution, or (2) chemical injection and mixing immediately prior to the distribution nozzles. In the event tank mix equipment is used, means shall be provided for constant agitation (either jet or mechanical) of the mixture during the filling and spraying operation. Each piece of equipment shall be equipped with a hand gun and nozzles capable of spreading the mixed solution uniformly, at the specified rate, over surface areas missed or inaccessible to the broadcast spraying.

Herbicide application equipment operated from the roadway or paved shoulder surface shall be equipped with a portable sequential arrow unit and impact attenuator or be immediately followed at all times by a shadow vehicle equipped with these two items.

Smaller motorized ground operated equipment may be used with the approval of the Engineer. This equipment may be used on smaller areas, such as landscaped areas within the limits of the right-of-way. The smaller areas are defined as the areas that are inaccessable to truck mounted and agricultural type sprayers normally used for broadcast applications from the roadway or open areas within the right-of-way. This smaller motorized ground operated equipment shall be equipped with a hand gun and/or nozzles capable of spreading the mixed solution uniformly over the area to be treated. Means shall be provided for constant agitation (either jet or mechanical) of the mixture during the filling and spraying operations.

2. Equipment for Spot Spraying.

Spot spraying by means of hand guns, backpack sprayers, portable tanks, etc., shall be capable of applying the herbicide solution at the designated plan rate or as directed by the Engineer. Herbicides placed with this type equipment shall dispense solution which contains the correct herbicide to carrier ratio. The herbicide solution shall be directed and placed on the target area to provide uniform, adequate and proper coverage in accordance with label instructions and as directed by the Engineer.

(b) Methods of Operation

Prior to beginning work, a conference between representatives of the Department and the Contractor will be arranged by the Department. In this meeting plans, specifications, unusual conditions, methods for marking non-sprayable areas, and other pertinent items regarding the work will be discussed. Certain "No-Spray" areas may occur; these fall within the defined limits of the spraying area as indicated by the plans and specifications. These areas are where various businesses or agencies have ornamental plantings or improved turf within the highway right-of-way and perform their own maintenance, or as directed by the Engineer. The Department will determine all non-sprayable areas.

Spraying will not be permitted when, in the opinion of the Engineer, soil, vegetation, and/or weather conditions are such that the right-of-way or the vegetation would be damaged or spraying would be ineffective.

The Contractor shall spray as close as practicable to all fixed objects, exercising extreme care not to damage trees, plants, shrubs, signs, delineators or other appurtenances which are part of the facility. Any damage caused by the Contractor's spraying operations to any tree, plant, shrub, sign, delineator or other appurtenance which is part of the facility shall be pruned, trimmed, repaired or replaced immediately by the Contractor at no cost to the Department. The Engineer will determine whether the damage shall be corrected by pruning, trimming, repair or replacement.

The Contractor shall be responsible for any damage to public or private property which may occur as a result of the spraying operation.

(c) Spraying Application Requirements.

The Contractor shall possess the appropriate license and permit required by the State of Alabama Department of Agriculture and Industries for conducting business in the State of Alabama.

All personnel directly involved in the application of the herbicide solution, to include operators and project supervisory personnel, shall be experienced in the ground application of pesticides on highway rights-of-way.

Operators and project supervisors involved with this project shall possess a commercial applicator permit issued by the State of Alabama Department of Agriculture and Industries covering the "Right-of-Way" category.

The Contractor will furnish two copies of product labels and material safety data sheets for the products used on the project. One copy of each will be furnished to the Engineer and one copy will be kept with the vehicles applying the herbicide at all times.

While spraying, care shall be exercised to prevent damage by spray drift or direct contact of herbicide to areas containing plantings of shrubs and bushes, designated wildflower areas, deciduous or evergreen trees, residential plantings, vegetable or flower gardens, any susceptible farm crops, or other desirable plants. In the event of damage to any desirable plants which includes damage or "brown-out" to low hanging limbs of trees along the right-of-way, the Contractor will correct by either replacement, pruning, trimming or compensation of any damages caused by the misapplication or drift of the herbicide solution immediately following visual recognition, verbal or written notification and/or instructions from the Engineer.

No herbicide solution shall be sprayed without a drift control agent. No spraying shall be undertaken when the wind velocity is 5 mph {8 km/h} or greater.

No spraying shall be undertaken during a rain, when rain is imminent, or when foliage is wet. In the event a rain occurs producing a rainfall of one-tenth of an inch {2.5 mm} within four hours or less after the treatment of an area, the area shall be retreated without additional compensations. No spraying shall be undertaken during extended periods of extremely high temperatures and drought conditions.

The Contractor shall take extreme care to insure that herbicide does not enter any lake, stream, pond or wetlands.

The speed of any vehicle used to apply the herbicide solution to the highway right-of-way, shall not exceed 11 mph {18 km/h} when operated from the roadway/paved shoulder surface or 5 mph {8 km/h} when operated off the improved portion of the roadway.

The pattern of spray shall be such as to provide even, uniform coverage.

(d) Liability of Contractor

The Contractor shall assume all liability for any damage resulting from the application of the herbicides for this project and shall hold the State of Alabama harmless from any claims arising from this damage. It is illegal to place herbicides in a manner that is not consistent with the requirements shown on the herbicide container labeling

(e) Record of Work

It shall be the Contractor's responsibility to "scout ahead" for each day's anticipated work. Department-furnished forms (BM-196) "Herbicide Scouting Report" shall be completed prior to the beginning of each day's work. A completed and signed copy shall be furnished to the Department's Engineer for each day's operation.

The Contractor shall account for each day's work and provide information on location, area covered, weather conditions, personnel, equipment, herbicide used, rates and productivity. This information shall be provided on the Department's "Herbicide Treatment Report", which will be provided by the Department. A completed and signed copy of this report shall also be furnished to the Department's Engineer for each day's work.

669.04 Method of Measurement

Item 669-A will be measured in acres {hectares} computed from surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 of an acre {0.1 ha}.

Item 669-B will be measured by the gallon {liter} of dispensed solution with measurements taken from the storage vessel before and following dispersal to determine the actual amount of solution used. Computations will be to the nearest gallon {L}.

Item 669-C will be measured by the square yard {square meter} of dispensed solution with surface measurements taken parallel to the treated surface. Computations will be to the nearest 0.1 square yard {0.1 square meter}.

669.04 Basis of Payment

(a) Unit Price Coverage

Payment for all satisfactorily completed work of pre-emergent herbicide application as specified, measured as provided above, will be paid for at the contract bid price which shall be full compensation for furnishing all labor, equipment, herbicides, adjuvants, carrier, fuels, incidentals and liability insurance necessary to complete the work. Partial payments will be made on monthly estimates based on the percentage of the total work performed as estimated by the Engineer.

(b) Payment will be made under Item No.:

669-A Broadcast Post-Emergent Herbicide Treatment (*) (**) (***) (****) per acre {ha}

669-B Spot Post-Emergent Herbicide Treatment (*) (**) (***) (****) per gallon {L}

669-C Spot Post-Emergent Herbicide Treatment (*) (**) (***) (****) per square yard {square meter}

* Specify Type
** Specify Rate
*** Specify Carrier Rate of Application
**** Specify Type of Carrier

SECTION 672
STORMWATER TURBIDITY CONTROL

672.01 Description.

This Section shall cover active and passive treatment methods of reducing the turbidity level of construction stormwater. Turbidity is typically the result of fine soil particles of erodible material exposed during construction, dislodged by precipitation and runoff, and subsequently suspended in stormwater. Conventional means of erosion and sediment control are not designed to remove turbidity

from construction stormwater. Additional measures must be implemented to remove the suspended materials from the water. Chemical flocculants are used to increase the particle size of suspended materials making them easier to remove. Prior to discharging construction stormwater, flocculated materials should be removed to the maximum extent practicable.

Active treatment should be used as a supplement to passive treatment for stormwater discharges that do not meet water quality standards. Active treatment typically employs mechanical pumping of captured stormwater as the means of introducing flocculant prior to mechanical filtering of flocculated materials.

Passive treatment typically employs precipitation and runoff as the means of introducing flocculant prior to physical settling of flocculated materials, typically by means of filtering devices and sedimentation basins.

672.02 Materials.

(a) Active Treatment System.

The Active Treatment System shall be designed to treat and reduce the turbidity level of construction stormwater discharges to meet state water quality standards and the requirements of the NPDES Construction General Permit at the flowrate required in the plans. The Active Treatment System flowrate specified is designed to dewater the basin within 10 hours. Typical equipment and materials may include pumps, manifolds, flocculants, filter bags, sand media filters and other items designed to remove suspended materials from construction stormwater. The Contractor shall submit to the Engineer the proposed Active Treatment System for review as part of the Contractor's Stormwater Management Plan that is described in Subarticle 108.04(b).

(b) Flocculant.

Flocculant shall be of the type that is manufactured for use in reducing turbidity caused by soil erosion and sediment transport. All forms of Flocculant utilized on a project shall be compatible and shall be provided from a single manufacturer. Flocculant may be in the form of blocks, powder, sock sets or other non-liquid forms. Liquid forms of Flocculant may only be utilized in a monitored active treatment system. The Contractor shall be responsible for the testing of the project soil and potential sediment and for the proper selection of those Flocculants that have a soil specific chemical makeup. Flocculant application rates shall be per the manufacturer's recommendations.

A list of acceptable Flocculants (LIST II-24 "TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". For Flocculants without prior acceptance, Contractor shall submit to the Engineer three copies of documentation of the effectiveness of the Flocculant, Material Safety Data Sheets, and the manufacturer's 7-day Chronic Ceriodaphnia Reproduction Testing for review and approval by the State Construction Engineer prior to use on the project.

(c) Contractor Retained Turbidimeters.

Turbidimeters shall be devices capable of measuring the nephelometric turbidity units (NTU) of construction stormwater that meets the following requirements:

- Portable waterproof device that meets USEPA Method 180.1 with a 0-1000 NTU range;
- Sample Tubes, Calibration Kit, and Protective Carrying Case;
- Rechargeable Battery, USB Interface, Cable, and Computer Software.

A list of equipment acceptable for use in this application (List II-24 "TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL PRODUCTS") is given in the ALDOT manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f).

672.03 Construction Requirements.

(a) Active Treatment.

The Contractor shall provide an Active Treatment System at the locations given in the plans or as directed by the Engineer. Treated construction stormwater discharges that do not meet state water quality standards or that do not meet the requirements of the NPDES Construction General Permit (CGP) will not be allowed.

Active Treatment Systems will typically be utilized for the dewatering of sedimentation basins. Valves located on the outlet pipe of the basin dewatering device shall remain closed until such time that the potential discharge meets state water quality standards and the requirements of the NPDES CGP. If discharge standards are not met and the sedimentation basin volume reaches 2/3 full or there

is forecasted rain, the Engineer will determine if the basin should be dewatered by means of the Active Treatment System. Weather permitting, discharges may be recirculated into sedimentation basins in an effort to achieve discharge standards. The Engineer may also direct dewatering by means of the Active Treatment System to facilitate sedimentation basin maintenance. The Contractor shall ensure proper Flocculant dosing of the Active Treatment System per the manufacturer's dosing recommendations to prevent the discharge of any harmful levels of Flocculant. The turbidity level of the Active Treatment System discharge and the effectiveness of the Flocculant shall be monitored by the Contractor and will be verified by the Engineer.

(b) Passive Treatment.

The Contractor shall apply Flocculant at the locations given in the plans or as directed by the Engineer. Flocculant shall be introduced to flowing stormwater at locations such as ditch checks, temporary slope drains and forebays of sedimentation basins, prior to retention BMPs intended to promote settling and capture of flocculated material. Heavy sediment and sand should be captured prior to the location of the Flocculant application. Flocculant shall never be applied directly to live streams or waters of the state. Flocculant shall be applied in accordance with the Flocculant manufacturer's dosing recommendations and the requirements shown on the plans for construction stormwater turbidity reduction. The effectiveness of the Flocculant will be monitored by the Engineer. ALDOT and Contractor QCIs shall inspect Flocculant applications after each rain event to determine if the reapplication of Flocculant is needed.

(c) Construction Stormwater Sampling and Turbidity Monitoring.

When construction stormwater sampling and turbidity monitoring is required per Item 107.21(e)2., the Contractor shall furnish the required quantity of Turbidimeters for use by the Engineer. The Contractor shall provide documentation of professional calibration of the device prior to delivery to the project and shall maintain annual professional calibration during the time that it is required on the project. Daily calibration and required stormwater sample testing shall be performed by the Engineer. The Contractor shall immediately replace any Turbidimeters that are in need of annual professional calibration or are otherwise not properly functioning, without additional compensation. The Contractor shall retain ownership of the device and will be notified once the Engineer determines that the device is no longer needed.

672.04 Method of Measurement.

(a) Active Treatment System.

Active Treatment System (Item 672-A) will be measured per each.

(b) Active Treatment System, Operating Day.

Active Treatment System, Operating Day (Item 672-B) will be measured per each. Operating days shall be measured individually for each Active Treatment System.

(c) Flocculant Application.

Flocculant Application (Item 672-C) will be measured per each based on the type of application (ditch check, temporary slope drain, sedimentation basin, or inlet protection).

(d) Contractor Retained Turbidimeters.

Contractor Retained Turbidimeters (Item 672-D) will be measured per each.

672.05 Basis of Payment.

(a) Unit Price Coverage.

Payment for Active Treatment System shall be full compensation for all equipment costs for a complete system designed to dewater at the required flowrate given in gallons per minute (GPM), including but not limited to delivery, installation, maintenance, and rental fees. Payment will not be made for the replacement of an Active Treatment System that does not produce discharges meeting requirements.

Payment for an Operating Day of the Active Treatment System shall be full compensation for all labor and material costs to operate one complete system at the required flowrate given in gallons per minute (GPM), for up to 10 hours, including but not limited to Flocculant, filter media, and other consumables. Payment shall only be made for operation directed by the Engineer.

Payment for flocculant shall be full compensation for testing (if required), furnishing and placing the flocculant.

Payment for the accepted Turbidimeter shall include furnishing of the device with all the required accessories and for any required calibrations. Payment shall be for the exclusive use of the device for the duration of the contract or until the Engineer determines that there will be no further need for the device.

(b) Payment will be made under Item No.:

672-A Active Treatment System, ____ GPM – per each
672-B Active Treatment System, ____ GPM, Operating Day – per each
672-C Flocculant Application, __*_ – per each
672-D Contractor Retained Turbidimeter – per each

* Ditch Check, Temporary Slope Drain, Sedimentation Basin, or Inlet Protection

SECTION 674
CONSTRUCTION SAFETY FENCE

674.01 Description.

This Section shall cover the work of furnishing, erecting, maintaining, and removing construction safety fence as shown on the plans, or directed by the Engineer, for the purpose of directing pedestrian traffic safely through construction work areas.

674.02 Materials.

Construction Safety Fence shall consist of a plastic, open-mesh fencing material, which shall be bright orange in color, and mounted on posts by means of adjustable belts or loops or other means that will securely hold the fencing in an upright position.

Posts may be of any type material that will adequately serve the intended purpose for the duration of the project.

Fence material shall weigh at least 12 pounds per 100 foot long roll (four foot wide roll) {5.4 kg per 30 meter long roll} ({1.21 meter wide roll}).

The Department has established a list (List V-7) of acceptable Construction Safety Fences. The Contractor may furnish any of the safety fences shown on this list. The list is given in the Department's manual, "MATERIAL, SOURCES AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS."

674.03 Construction Requirements.

Construction Safety Fence shall be installed as shown in the plans and as directed by the Engineer.

The fence shall be continuous, four feet in height above the ground surface, and shall be spliced together only at support posts with a minimum 6 inch {150 mm} overlap. The maximum spacing between posts shall be 10 feet {3 meters}.

The Contractor shall maintain the integrity of the fence as long as the engineer deems necessary and while construction or associated activities are ongoing in the vicinity of the area enclosed or delineated by the fence.

The Contractor shall routinely inspect the fence and correct any deficiencies immediately. The fence shall remain in place until the Engineer directs that it be removed. The fence materials shall remain the property of the Contractor and may be reused at other locations, provided they are in satisfactory condition for reuse as determined by the Engineer.

Posts and the hardware for attaching the construction safety fence to the posts shall be considered a necessary requirement of the construction safety fence installation and no direct payment will be made for such.

674.04 Method of Measurement.

Construction Safety Fence will be measured in linear feet {meters} to the nearest 0.1 of a foot {0.1 meter} along the line of the completed fence.

674.05 Basis of Payment.

(a) General.

The unit price for Construction Safety Fence shall be payment in full for furnishing all materials and for all labor, tools, equipment, and incidentals necessary for performing all work involved in constructing, maintaining, removing, and disposing of the construction safety fence.

(b) Payment will be made under Item No.:

674-A Construction Safety Fence - per linear foot {meter}

SECTION 680
GEOMETRIC CONTROLS

680.01 Description.

When this item is included in the proposal, it shall consist of the Contractor furnishing, placing, and maintaining construction stakes, lines, and grades necessary for establishing the accurate location of all features of construction.

680.02 Materials.

All materials needed in the performance of the work of Geometric Controls shall be furnished by the Contractor.

680.03 Construction Requirements.

(a) Determination of Lines and Grades.

The Engineer will furnish centerline control points (P.C.s, P.O.C.s, P.T.s, P.O.T.s, etc.) at intervals determined necessary by the Engineer for the Contractor to establish alignment on all roadways. Where ramps, cross roads, service roads, etc. are geometrically tied to the mainline roadway, the Engineer will only establish control points along the mainline of the roadways. The Engineer will stake breaks of rights-of-way and mark the clearing limits.

Bench marks will be furnished at intervals along the project for vertical control. Sufficient design roadway cross section information (elevations, slope ratios, etc.) will be provided to enable the Contractor to establish grade stakes and slope stakes. Alignment data and flowline data for drainage structures (including box culverts) will be furnished by the Engineer. For each bridge site, except box culverts, the Engineer will furnish a minimum of two horizontal control points and one bench mark for vertical control.

(b) Contractor's Responsibility.

1. Contractor's Responsibility for Establishing Geometric Controls.

The Contractor shall be responsible for all layout and geometric control work necessary for construction of all items of work. The Contractor shall use the plans, controls and other data furnished by the Engineer in establishing the required location of all features of the work. The Contractor shall be responsible for the utilization and preservation of all furnished controls. The Contractor shall replace State furnished control stakes or marks that are disturbed by the Contractor during construction.

2. Contractor's Responsibility to Check Furnished Controls.

The Contractor shall check all furnished controls as a first order of work to be assured that they are accurate. The Contractor's use of all furnished points and marks for construction of the project shall be acceptance of the responsibility for the accuracy of these controls. By acceptance of responsibllity for the accuracy of the controls the Contractor waives all claims for extra compensation for corrective work if the controls are later found to be incorrect. All discrepancies shall be reported immediately to the Engineer in writing.

3. Setting Geometric Controls for Roadway Construction.

The Contractor shall mark or monument the locations of the finished subgrade along the centerline, at the edges of lanes and at breakpoints. Markings or monuments shall be provided at intervals of 100 feet {30 m} on tangent alignments and at intervals of 50 feet {15 m} on curved alignments. The type of marking or monument shall be suitable for the purpose of checking the vertical and horizontal position of the location against the required position shown in the plans. The type of marking or monument shall be approved by the engineer prior to being set.

The Contractor shall also mark or monument locations on each layer of soil or aggregate base at transverse breakpoints on these layers at intervals of 50 feet {15 m}.

4. Setting Geometric Controls for Bridge Construction.

For all bridge work the Contractor shall establish and maintain all horizontal and vertical control points, and furnish all lines and grades necessary for the bridge construction from the initial layout

to the final acceptance of the bridges. The Contractor shall accurately set all forms, headers, rails, and screeds to provide the dimensions, elevations, and grades shown on the plans.

680.04 Method of Measurement.

Measurement of the item of Geometric Controls will be made on a lump sum basis. When more than one project is included in a contract, each project will be assigned a fractional part of the lump sum as shown on the plans.

680.05 Basis of Payment.

(a) Unit Price Coverage.

The item of Geometric Controls, measured as noted above, will be paid for at the contract lump sum price bid. Said lump sum shall be full compensation for furnishing all materials (hubs, stakes, templates, straightedges), equipment, tools, labor, and incidentals necessary to complete this item of work.

Partial payments for the item of Geometric Controls will be made on monthly estimates. The amount paid each month will be a percentage of the lump sum contract amount. This percentage shall be the same as the percentage of work performed during the estimate period.

When more than one project is included in a contract, the amount of a partial payment will be the sum of separate calculations made for each project.

(b) Payment will be made under Item No.:

680-A Geometric Controls - per lump sum

SECTION 698
CONSTRUCTION FUEL COST

698.01 Description.

This Section shall cover the cost of construction fuel for the equipment necessary for the performance of the required work except for the production of Hot Mix Asphalt (HMA).

698.02 Bidding and Cost Adjustment.

The bidder shall enter an amount from zero dollars up to the maximum dollar amount shown in the pay item description for fuel on the proposal form. The Contractor signifies that this amount represents a reasonable estimate of the fuel costs isolated from all other costs of completing the required work except for the production of HMA.

If a proposal contains an amount greater than the maximum amount shown in the pay item description, the amount bid for Construction Fuel will be assigned a value that is the maximum amount.

A cost adjustment will be made to the amount of compensation due for construction fuel on each estimate. This cost adjustment will be based on the cost of the fuel at the time of bid and the cost of fuel at the time of the estimate.

698.03 Method of Cost Adjustment.

The Department will determine and publish a monthly "Fuel Index" utilizing the average area terminal price reports for regular unleaded gasoline and No. 2 fuel of the "Platts Oilgram Price Report" published during the week in which the first day of the month occurs.

The Base Fuel Index (I_b) for the project will be the monthly fuel index published for the month in which the bids were opened for the project.

Before the expiration of contract time partial payments will be made on monthly estimates using the following formula:

$P = (I_m / I_b) X P_c$, where

P = Numerical portion of the lump sum bid amount, a number usually less than one. (Round to nearest thousandth.) May be expressed as a percentage of the lump sum by multiplying by 100 %.

I_m = Fuel Index for Current Monthly Estimate

I_b = Base Fuel Index

P_c = Percent of project completed during current estimate period, i.e., P_c = Percentage of project complete to date minus percent project complete at the time of previous estimate. Percentage

of project complete will not include payment for stored materials. (Round percentage to nearest thousandth. Example: 21.71% = 0.217)

After the expiration of contract time (plus approved time extensions) two calculations of a potential partial payment will be made. The first calculation will be made using the current index and the base index as noted in the preceding formula. The second calculation will be made using the index during the month that contract time (plus approved time extensions) expired and the base index. The smallest amount of partial payment resulting from these two calculations will be made for the current estimate period.

698.04 Basis of Payment.

(a) Unit Price Coverage.

The amount designated for construction fuel, shall be full compensation, after all applicable cost adjustments, for the furnishing of fuel for equipment used on the project, except for the fuel for the production of HMA, and for all materials, equipment, tools, labor, transportation and incidentals necessary for its use.

(b) Payment will be made under Item No.:

698-A Construction Fuel (max. bid limited to $_____) - per Lump Sum

DIVISION 700
TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING

SECTION 701
TRAFFIC STRIPE

701.01 Description.

This Section shall cover the work of placing a permanent or temporary traffic stripe at the locations shown on the plans or where directed by the Engineer. This Section shall also cover the removal of existing or temporary traffic stripe.

701.02 Materials.

Materials shall be furnished in accordance with the requirements given in Sections 856 and 857. The required dimensions, color, class, retroreflectivity and type of stripe will be shown on the plans.

The required type of material will be designated by "Class" in accordance with the following.

CLASS OF TRAFFIC STRIPE	
CLASS	MATERIAL
1	Paint
1H	High Build Paint
2	Standard Thermoplastic Material
2T	Thin Film Spray Applied Thermoplastic Material
3	Tape
W	Warranted Traffic Marking Material

The required reflectivity will be designated by "Type" in accordance with the following.

TYPE OF TRAFFIC STRIPE	
TYPE	REFLECTIVITY
A	Reflective
B	Non-reflective

Class 1H, Class 2, and Class 2T materials shall be in compliance with the formulations given in the tables in Section 856 for each class.

Class 1, Class 3, Class W, and Drop On Glass Beads shall be one of the materials shown on List V-3, Temporary Traffic Marking Materials, and List V-4, Permanent Traffic Marking Materials. These lists are in the Department's Manual, "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning these lists is given in Subarticle 106.01(f) and ALDOT-355.

701.03 Construction Requirements.

(a) Acceptance Program for Traffic Marking Materials.

The guidelines for the evaluation and acceptance of traffic marking materials are given in the procedure ALDOT-420 "Acceptance Program for Traffic Marking Materials". These guidelines shall be followed in the furnishing and placement of stripe.

(b) Temporary Traffic Stripe.

1. Requirement for Use.

A roadway shall not be opened to traffic without a traffic stripe unless approved otherwise by the Engineer. Lane lines shall be maintained at all times when traffic is required to pass through the areas of construction. Existing lane lines covered by paving operations shall be replaced with temporary stripe.

Temporary edge lines will not be required unless shown to be required on the plans or required by the Engineer.

2. Allowable Material.

Temporary traffic stripe shall be reflective and shall be:

- Permanent Traffic Marking Materials (Class 1, LIST V-4) or;

- Removable Tape (List V-3).

3. Weather Conditions for Application.

Temporary striping may be placed without regard to the weather conditions if allowed by the Engineer.

4. Configuration.

A broken line of temporary stripe shall consist of 4 inch {100 mm} wide by 8 foot {2.4 m} long markings placed on 40 foot {12 m} centers. A solid line of temporary stripe shall be a continuous 4 inch {100 mm} wide stripe. Other width stripes may be required as shown on the plans.

5. Temporary Traffic Marking Tape.

Temporary traffic marking tape shall be applied as recommended by the tape manufacturer or as directed by the Engineer. Any failure of traffic marking tape shall be repaired immediately.

6. Removal.

A temporary solid line stripe of marking tape used on an underlying pavement layer, or any type temporary stripe of marking tape used on a wearing surface shall be removed.

A temporary solid or broken line stripe of paint used on a wearing surface shall be removed if it is not to be completely covered with a Class 1H or 2 permanent stripe.

Other types of temporary stripe may remain in place if the temporary stripe will be covered by the placement of paving layers or permanent stripe.

(c) Class 1 Paint.

1. Usage.

Class 1 paint shall be used for temporary striping unless shown otherwise on the plans. Class 1 paint shall not be applied to concrete surfaces.

2. Surface Preparation.

Areas to be striped shall be thoroughly cleaned of all dirt, oil and other debris in a way that will not damage the pavement surface. Striping shall not begin until the Engineer has inspected the pavement surface and has informed the Contractor that striping may begin.

3. Weather Conditions for Application.

Class 1 paint may be placed without regard to the weather conditions if allowed by the Engineer.

4. Equipment for Application.

Equipment for the application of Class 1 paint shall be designed to place the paint and reflective beads when required. The equipment shall be capable of placing the materials at the required rates of placement and within the allowable placement tolerances.

5. Rate of Placement.

Class 1 paint for temporary applications shall be placed at the rate of 10 gallons per mile for a 4 inch wide solid stripe {24 L/km for a 100 mm wide solid stripe} except for the following circumstances. The rate of placement for temporary applications shall be 18 gallons per mile for a 4 inch wide solid stripe {43 L/km for a 100 mm wide solid stripe} on rough pavement surfaces such as Open Graded Friction Course (OGFC), milled surfaces, or when used as a temporary stripe that will not be covered within 60 calendar days.

Class 1 paint for permanent applications shall be placed at the rate of 22.5 gallons per mile for a 5 inch wide solid stripe {53.8 L/km for a 125 mm wide solid stripe} except for the following circumstances. The rate of placement for permanent applications shall be 27.5 gallons per mile for a 5 inch wide solid stripe {65.0 L/km for a 125 mm wide solid stripe} on rough pavement surfaces such as Open Graded Friction Course (OGFC) and milled surfaces.

The rates of placement for other widths of stripe and for broken stripe shall be the prorated rates of placement determined from the placement rates given for 5 inch {125 mm} solid stripe.

Paint stripe that is placed at a rate that is not greater than 95 % of the required rate shall be replaced if the stripe is not accepted by the Engineer with an approved price reduction.

6. Placement of Reflective Beads.

Type 1 glass beads shall be placed at a rate of 146.3 pounds per mile for a solid 5 inch wide stripe {41.3 kg/km for 125 mm wide solid stripe}. Prorated rates of application shall be made other widths of stripe and for broken stripe. Beads shall be applied before the final set of the paint has occurred to insure that the beads will adhere to the paint.

(d) Class 1H, High Build Paint.

1. Usage.

Class 1H paint shall be used for State maintenance operations only.

Class 1H paint may be applied to asphalt and concrete surfaces. Asphalt pavement shall be allowed to cure for a period of 14 calendar days before the application of the Class 1 H paint. Concrete pavement shall be allowed to cure for a period of 30 calendar days before the application of the Class 1 H paint.

2. Surface Preparation.

Areas to be striped shall be thoroughly cleaned of all dirt, oil and other debris in a way that will not damage the pavement surface. Striping shall not begin until the Engineer has inspected the pavement surface and has informed the Contractor that striping may begin.

Curing compound on concrete surfaces shall be removed by grinding, wire brushing, sand blasting or other effective means.

3. Weather Conditions for Application.

Permanent Class 1H paint shall not be placed during rain or mist or if the pavement surface is wet. Class 1H paint shall only be placed when the pavement temperature is 45 ºF {7 ºC} and rising.

4. Equipment for Application.

Equipment for the application of Class 1H paint shall be designed to place the paint, and reflective beads when required, at the required rates of placement and within the allowable placement tolerances.

5. Rate of Placement.

Class 1H paint shall be placed at the rate given in the following table. Rough pavement surfaces are such surfaces as Open Graded Friction Course (OGFC) and milled surfaces.

Class 1H paint shall be placed at the rate of 34.3 gallons per mile for a 5 inch wide solid stripe {81.8 L/km for a 125 mm wide solid stripe} except for the following circumstances. The rate of placement for permanent applications shall be 40.5 gallons per mile for a 5 inch wide solid stripe {96.8 L/km for a 125 mm wide solid stripe} on rough pavement surfaces such as Open Graded Friction Course (OGFC) and milled surfaces.

The rates of placement for other widths of stripe and for broken stripe shall be prorated rates determined from the placement rates given for 5 inch {125 mm} solid stripe.

Class 1H paint stripe that is placed at a rate that is not greater than 95 % of the required rate shall be replaced if the stripe is not accepted by the Engineer with an approved price reduction.

The required width of the stripe will be shown on the plans.

6. Placement of Reflective Beads.

Type 3 glass beads shall be placed on the Class 1H paint at a rate of 220 pounds per mile for a 5 inch solid wide stripe {93.7 kg/km for 125 mm wide solid stripe}. The rates of placement for other widths of stripe and for broken stripe shall be prorated rates determined from the placement rates given for 5 inch {125 mm} solid stripe.

7. Retroreflectivity.

The target retroreflectivity shall be 300 mcd/lux/sq m for white stripe and 200 mcd/lux/sq m for yellow stripe.

The Engineer will measure the retroreflectivity of edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210, "Selecting Samples by the Random Numbers Method".

If the average of the 5 retroreflectivity measurements is 85 % of the target retroreflectivity, or greater, the stripe will be accepted without a price adjustment for retroreflectivity.

If the average of the 5 retroreflectivity measurements is less than 85 % and greater than 50 % of the target retroreflectivity, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target retroreflectivity, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 retroreflectivity measurements is 50 % of the target retroreflectivity, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target retroreflectivity shall be removed and replaced without extra compensation.

Retroreflectivity measurements will be made in accordance with the requirements given in ALDOT-422 "Method of Retroreflectivity Measurement of Traffic Marking Materials" with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe.

8. Color and Luminance Factors.

The color and luminance factors shall meet the requirements given in Section 856.

(e) Class 2, Standard Thermoplastic.

1. Usage.

Class 2 thermoplastic shall be used for permanent striping, and for other circumstances designated by the Engineer. Class 2 thermoplastic may be applied to asphalt and concrete surfaces. Asphalt pavement shall be allowed to cure for a period of 14 calendar days before the application of the thermoplastic. Concrete pavement shall be allowed to cure for a period of 30 calendar days before the application of the thermoplastic.

2. Surface Preparation.

Areas to be striped shall be thoroughly cleaned of all dirt, oil and other debris in a way that will not damage the pavement surface.

Curing compound on concrete surfaces shall be removed by grinding, wire brushing, sand blasting or other effective means.

A primer, sealer or surface preparation adhesive of the type recommended by the manufacturer of the Class 2 thermoplastic shall be applied to concrete surfaces (concrete pavement and bridge decks) before the application of the thermoplastic. Longitudinal stripes shall be offset at least 2 inches {50 mm} from longitudinal joints in concrete surfaces.

Striping shall not begin until the Engineer has inspected the pavement surface and has informed the Contractor that striping may begin.

3. Weather Conditions for Application.

Class 2 thermoplastic shall not be placed during rain or mist or if the pavement surface is wet. The pavement surface temperature shall be at least 50 °F {10 °C} and rising before application will be allowed to asphalt pavement surfaces. The pavement surface temperature shall be at least 60 °F {16 °C} and rising before application will be allowed to concrete pavement surfaces.

4. Equipment for Application.

The equipment shall be capable of placing thermoplastic and beads at the required rates of placement and within the allowable placement tolerances.

The equipment shall have the capacity to maintain the thermoplastic at temperatures greater than 390 °F {200 °C}. The temperature of the thermoplastic shall be greater than 390 °F {200 °C} at the point of application.

The equipment shall be capable of applying glass beads to the surface of the stripe by a double drop application. The bead dispenser for the first bead drop shall be attached to the striping machine so that the beads are dispensed closely behind the thermoplastic material. The second bead dispenser shall be attached to the striping machine so that the beads are dispensed immediately after the first bead drop application. The bead dispensers shall be equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material. The dispensers shall apply the glass beads to produce a uniform appearance on the entire surface of the stripe and 50 % embedment of the beads. The Engineer will make the determination of the acceptability of the bead embedment by visual inspection.

5. Required Thickness.

Class 2 thermoplastic shall be placed to a target uniform thickness of 0.100 inches {2.5 mm. The required width of the stripe will be shown on the plans.

The Engineer will measure the thickness of the edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 thickness measurements is 85 % of the target thickness, or greater, the stripe will be accepted without a price adjustment for thickness.

If the average of the 5 thickness measurements is less than 85 % and greater than 50 % of the target thickness, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target thickness, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 thickness measurements is 50 % of the target thickness, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target thickness shall be removed and replaced without extra compensation.

Thickness and width measurements will be made in accordance with the requirements given in ALDOT-423 "Method of Measuring Traffic Stripe and Traffic Control Legends and Markings" with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe. The removal and replacement shall be done without additional compensation.

6. Placement of Reflective Beads.

The Contractor shall use either one of the optional double drop bead systems shown in the following tables.

OPTION 1 > AASHTO TYPE 4 BEADS AND AASHTO TYPE 1 BEADS		
Type of Reflective Beads	AASHTO Type 4	AASHTO Type 1
Order of Placement	First	Second
Minimum Rate of Placement	6 pounds per 100 square feet {2.7 kg per 9.3 m^2}	8 pounds per 100 square feet {3.6 kg per 9.3 m^2}

OPTION 2 > 3M "REFLECTIVE ELEMENTS" AND AASHTO TYPE 3 BEADS		
Type of Reflective Beads	3M "Reflective Elements"	AASHTO Type 3
Order of Placement	First	Second
Minimum Rate of Placement	6.6 pounds per 100 square feet {3.0 kg per 9.3 m^2}	10 pounds per 100 square feet {4.5 kg per 9.3 m^2}

7. Retroreflectivity.

The target retroreflectivity shall be 450 mcd/lux/sq m for white stripe and 300 mcd/lux/sq m for yellow stripe.

The Engineer will measure the retroreflectivity of edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 retroreflectivity measurements is 85 % of the target retroreflectivity, or greater, the stripe will be accepted without a price adjustment for retroreflectivity.

If the average of the 5 retroreflectivity measurements is less than 85 % and greater than 50 % of the target retroreflectivity, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target retroreflectivity, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 retroreflectivity measurements is 50 % of the target retroreflectivity, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target retroreflectivity shall be removed and replaced without extra compensation.

Retroreflectivity measurements will be made in accordance with the requirements given in ALDOT-422 with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe.

8. Color and Luminance Factors.

The color and luminance factors shall meet the requirements given in Section 856.

(f) Class 2T, Thin Film Spray Applied Thermoplastic.

1. Usage.

Class 2T thermoplastic shall be used for permanent striping, and for other circumstances designated by the Engineer. Class 2T thermoplastic may be applied to asphalt and concrete surfaces. Asphalt pavement shall be allowed to cure for a period of 14 calendar days before the application of the thermoplastic. Concrete pavement shall be allowed to cure for a period of 30 calendar days before the application of the thermoplastic.

2. Surface Preparation.

Areas to be striped shall be thoroughly cleaned of all dirt, oil and other debris in a way that will not damage the pavement surface.

Curing compound on concrete surfaces shall be removed by grinding, wire brushing, sand blasting or other effective means.

A primer, sealer or surface preparation adhesive of the type recommended by the manufacturer of the Class 2T thermoplastic shall be applied to concrete surfaces (concrete pavement and bridge decks) before the application of the thermoplastic. Longitudinal stripes shall be offset at least 2 inches {50 mm} from longitudinal joints in concrete surfaces.

Striping shall not begin until the Engineer has inspected the pavement surface and has informed the Contractor that striping may begin.

3. Weather Conditions for Application.

Class 2T thermoplastic shall not be placed during rain or mist or if the pavement surface is wet. The pavement surface temperature shall be at least 50 °F {10 °C} and rising before application will be allowed to asphalt pavement surfaces. The pavement surface temperature shall be at least 60 °F {16 °C} and rising before application will be allowed to concrete pavement surfaces.

4. Equipment for Application.

Equipment for the application of Class 2T thermoplastic shall be designed to place the thermoplastic and beads at the required rates of placement and within the allowable placement tolerances.

The equipment shall have the capacity to maintain the thermoplastic at temperatures greater than 390 °F {200 °C}. The temperature of the thermoplastic shall be greater than 390 °F {200 °C} at the point of application.

5. Required Thickness.

Class 2T thermoplastic shall be placed to a target uniform thickness of 0.060 inches {1.5 mm}. The required width of the stripe will be shown on the plans.

The Engineer will measure the thickness of the edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 thickness measurements is 85 % of the target thickness, or greater, the stripe will be accepted without a price adjustment for thickness.

If the average of the 5 thickness measurements is less than 85 % and greater than 50 % of the target thickness, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target thickness, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 thickness measurements is 50 % of the target thickness, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target thickness shall be removed and replaced without extra compensation.

Thickness and width measurements will be made in accordance with the requirements given in ALDOT-423 with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe. The removal and replacement shall be done without additional compensation.

6. Placement of Reflective Beads.

Type 1 glass beads shall be placed on the Class 2T thermoplastic at a rate of 220 pounds per mile for a 5 inch solid wide stripe {93.8 kg/km for 125 mm wide solid stripe}. The rates of placement for other widths of stripe and for broken stripe shall be prorated rates determined from the placement rates given for 5 inch {125 mm} solid stripe.

7. Retroreflectivity.

The target retroreflectivity shall be 250 mcd/lux/sq m for white stripe and 175 mcd/lux/sq m for yellow stripe.

The Engineer will measure the retroreflectivity of edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 retroreflectivity measurements is 85 % of the target retroreflectivity, or greater, the stripe will be accepted without a price adjustment for retroreflectivity.

If the average of the 5 retroreflectivity measurements is less than 85 % and greater than 50 % of the target retroreflectivity, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target retroreflectivity, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 retroreflectivity measurements is 50 % of the target retroreflectivity, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target retroreflectivity shall be removed and replaced without extra compensation.

Retroreflectivity measurements will be made in accordance with the requirements given in ALDOT-422 with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe.

8. Color and Luminance Factors.

The color and luminance factors shall meet the requirements given in Section 856.

(g) Class 3, Tape.

Class 3 Tape shall be used for permanent striping, and for other circumstances designated by the Engineer.

Class 3 tape shall be applied in accordance with the procedures recommended by the manufacturer. Tape stripe shall not be placed when the pavement temperature is below 60 °F {16 °C}. Tape may be placed at lower temperatures if shown in the manufacturer's recommendations for placement and allowed by the Engineer.

The target retroreflectivity of the Class 3 tape shall be 450 mcd/lux/sq m for white tape and 350 mcd/lux/sq m for yellow tape.

The Engineer will measure the retroreflectivity of edge lines for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 retroreflectivity measurements is 85 % of the target retroreflectivity, or greater, the tape will be accepted without a price adjustment for retroreflectivity.

If the average of the 5 retroreflectivity measurements is less than 85 % and greater than 50 % of the target retroreflectivity, the tape will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target retroreflectivity, payment for the tape will be 65 % of the contract unit price.

If the average of the 5 retroreflectivity measurements is 50 % of the target retroreflectivity, or less, the tape shall be removed and replaced without extra compensation.

Any portion of the tape that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target retroreflectivity shall be removed and replaced without extra compensation.

Retroreflectivity measurements will be made in accordance with the requirements given in ALDOT-422 with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe.

(h) Warranted Traffic Marking Materials.

Class W traffic marking materials shall be used for permanent striping, and for other circumstances designated by the Engineer.

Class W traffic marking materials shall be applied in accordance with the procedures recommended by the manufacturer.

(i) Removing Stripe and Markers.

Existing traffic stripe (permanent or temporary), markers and adhesive shall be removed by a method that will not damage or disfigure the appearance of pavement surfaces that will be visible at the completion of construction. Burning the old stripe will not be permitted.

Hiding the old stripe by covering it with a striping material that is colored to match the appearance of the pavement surface will only be allowed if approved in writing by the Engineer. Covering the old stripe will only be considered for hiding what may remain of the stripe on rough pavement surfaces like Open Graded Friction Course after other methods of removal have failed to adequately remove the old stripe. The Contractor shall propose the type, color and application rate the striping material for review and approval by the Engineer. There will be no extra compensation given for furnishing and applying striping material to hide an existing stripe.

Removal of traffic stripe, existing or temporary, will be paid for as a separate item of work.

(j) Placement Location.

The Engineer will set the limits of no-passing zones. The Contractor shall provide all other controls required to place the stripe in accordance with the details shown on the plans or as directed by the Engineer. The Contractor shall mark the surfaces prior to the placement of the stripe to insure that the stripe will be installed in the required location.

The Contractor may be required to adjust the operation of the striping equipment to cover the width and length of existing stripe.

(k) Width and Length Placement Tolerances.

1. Permanent Striping.

A tolerance of 1/2 of an inch {13 mm} over or 1/8 of an inch {3 mm} under the required width will be allowed, provided the variation is gradual and does not detract from the general appearance. Segments of broken line may vary up to 1 foot {0.3 m} from the required length. Segments shall have neat edges without mist or drip. Variations from the control guide up to 1 inch {25 mm} will be allowed provided the variation does not increase or decrease at a rate of more than 1/2 of an inch {13 mm} in 20 feet {7.5 m}. Lines that do not meet these tolerances shall be removed and replaced, without additional compensation. Establishment of tolerances does not relieve the Contractor of responsibility to construct as closely as practicable to exact plan dimensions.

2. Temporary Stripe.

The width of the temporary stripe shall not exceed 4 inches {100 mm}, but shall have a 1/2 inch {13 mm} under tolerance. Traffic marking tape shall have a nominal 4 inch {100 mm} width. The tolerance for the lengths of the temporary broken stripe sections shall be 1 foot {0.3 m} under and 1 foot {0.3 m} over the length specified in Subitem 701.03(e)5.a. Strict compliance to alignment on underlying surfaces will not be required provided a reasonable straight line of markings is obtained. The tolerances for placement on a wearing surface shall be the same as those for permanent striping.

3. Failure to Meet Width and Length Placement Tolerances.

Permanent or temporary striping placed on a final wearing surface that does not meet the tolerances specified shall be removed and replaced without compensation. This includes areas where the permanent striping does not match the alignment, spacing, etc. of the temporary stripe, leaving the temporary stripe exposed.

Portions, or as much as the entire pavement surface, shall be overlaid with a bituminous plant mix layer in extreme cases of disfigurement of the pavement due to stripe removal. The Engineer will make the final determination of the severity of the disfigurement, the requirement for the extent of the overlay, and the material and placement requirements for the plant mix required for the overlay. The Contractor shall place the overlay without compensation.

(l) Protection Of Traffic Stripe.

Traffic shall be prevented from crossing traffic stripe that is not dried, cured or taken a set to bear the traffic. The Contractor shall use a sufficient number of flagmen or other protection for the stripe to prevent traffic from damaging the newly applied stripe.

Sections of traffic stripe that have been marred or picked up by traffic shall be repaired and the pavement shall be cleaned outside the limits of the stripe. Repair and cleaning shall be done by the Contractor without extra compensation.

(m) Protection Of Traffic.

The Contractor shall furnish and place without extra compensation all warning and directional signs required to direct, control and protect the traveling public while marking and striping operations are in progress. Temporary barricades and signs of the design shown on the plans or directed by the Engineer shall be placed as shown on the plans at the beginning and end of the section that the Contractor proposes to stripe in one operation. As soon as the striping material has dried or cured

sufficiently in any one section to permit traffic to cross the traffic line, the temporary barricades and signs shall be moved ahead to the next section. Barricades and signs shall not be left in place overnight.

The striping equipment shall be operated in a manner to cause the least disruption to the normal flow of traffic.

701.04 Method of Measurement.

(a) Items 701-A, 701-B, 701-C, 701-E, 701-F, and 701-G.

Solid or broken traffic stripe (Items 701-A, and 701-C) will be measured in miles {kilometers} along the centerline of each stripe either by direct measurement and computation to the nearest 0.001 mile {0.001 kilometer} or by odometer to the nearest 0.001 mile {0.001 kilometer}.

Solid, broken, or dotted traffic stripe (Items 701-B, 701-E, 701-F and 701-G) will be measured in linear feet {meters} along the centerline of the stripe to the nearest linear foot {meter}.

The length of broken traffic stripe and dotted traffic stripe complete in place and accepted will include the gaps shown on the plans as a part of the traffic line design but will not include the length of any other gap or section omitted by the Engineer.

Each width of traffic stripe will be measured separately for payment.

(b) Items 701-D and 701-H.

Any traffic stripe, existing or temporary, removed as directed (Items 701-D and 701-H) will be measured in the same manner noted for placement of the type stripe involved.

Removal of markings or legends will be measured and paid for under the appropriate item provided in Section 703.

701.05 Basis of Payment.

(a) Unit Price Coverage.

The length of Solid or Broken Traffic Stripe, Item 701-A, and the length of Solid or Broken Traffic Stripe, Item 701-G, measured as noted above, will be paid for at the respective contract unit prices and shall be full compensation for the stripe including the cleaning of the pavement, the furnishing and applying of the striping material, and for all equipment, tools, labor and incidentals necessary to complete the item of work.

The length of Dotted Traffic Stripe, Item 701-B, measured as noted above, will be paid for at the contract unit price which shall be full compensation for furnishing all materials of the appropriate color consistent with the use of the stripe in accordance with the plan details, the preparation of the pavement, the application of the striping material, and for all equipment, tools, labor and incidentals necessary to complete this item of work.

The length of Solid or Broken Temporary Traffic Stripe, Item 701-C, and the length of Solid or Broken Temporary Traffic Stripe, Item 701-E, and Dotted Temporary Traffic Stripe, Item 701-F, measured as noted above, will be paid for at the respective contract unit prices which shall be full compensation for the furnishing of all materials, of the appropriate color consistent with the use of the stripe in accordance with the requirements of the plan details and the MUTCD, the preparation of the surface, the placing of the material, the maintenance of the traffic stripe, and for all equipment, miscellaneous materials, tools, labor and incidentals necessary to complete the item of work.

The length of existing or temporary Solid or Broken Traffic Stripe Removed, Item 701-D, and the length of Solid, Broken, or Dotted Traffic Stripe Removed, Item 701-H, measured as provided above, will be paid for at the contract unit price which shall be payment in full for all materials, equipment, tools, and labor necessary to complete the work. When the traffic stripe to be removed consists of pavement markers used as traffic stripes the cost of removing markers, marker adhesive, and existing paint, plastic or tape located between the markers shall also be included in the price.

(b) Payment will be made under Item No.:

701-A Solid/Broken Color, Class * Type ** Traffic Stripe - per mile {kilometer}
701-B Dotted Class * Type ** Traffic Stripe - per linear foot {meter}
701-C Solid/Broken Temporary Traffic Stripe (***) - per mile {kilometer}
701-D Solid/Broken Traffic Stripe Removed (***) - per mile {kilometer}
701-E Solid/Broken Temporary Traffic Stripe (***) - per linear foot {meter}
701-F Dotted Temporary Traffic Stripe (***) - per linear foot {meter}
701-G Solid/Broken Color, Class * Type ** Traffic Stripe - per linear foot {meter}
701-H Solid/Broken/Dotted Traffic Stripe Removed (***) - per linear foot {meter}

* Specify "1", "1H", "2", "2T", "3", or “W”.

** Specify "A" or "B".
*** Specify "Paint", "Plastic", "Tape", etc., only if required.

SECTION 703
TRAFFIC CONTROL MARKINGS AND LEGENDS

703.01 Description.

This Section shall cover the work of placing permanent or temporary traffic control markings and legends at the locations shown on the plans or where directed by the Engineer. Preformed thermoplastic markings may be used for permanent striping, and for other circumstances as designated by the Engineer. This Section shall also cover the removal of existing or temporary traffic control markings and legends.

703.02 Materials.

(a)General.

Materials shall be furnished in accordance with the requirements given in Sections 856 and 857. The required dimensions, color, type of material and reflectivity will be shown on the plans.

The required type of material will be designated by "Class" and "Type" in accordance with the requirements given Section 701

Class 1H, Class 2, and Class 2T materials shall be in compliance with the formulations given in the tables in Section 856 for each class.

Class 1, Class 3, Class W, Preformed Traffic Markings, and Drop On Glass Beads shall be one of the materials shown on List V-3, Temporary Traffic Marking Materials, and List V-4, Permanent Traffic Marking Materials. These lists are in the Department's Manual, "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning these lists is given in Subarticle 106.01(f) and ALDOT-355.

Preformed traffic markings and legends shall also meet the requirements given in Article 856.09. All preformed traffic markings and legends shall meet the dimensions as shown in the plans and shall meet the tolerance requirements given in Item 703.03(c)1.

703.03 Construction Requirements.

(a) Acceptance Program for Traffic Marking Materials.

The guidelines for the evaluation and acceptance of traffic marking materials are given in the procedure ALDOT-420 "Acceptance Program for Traffic Marking Materials". These guidelines shall be followed in the furnishing and placement of traffic markings and legends.

(b) Temporary Traffic Markings and Legends.

Temporary traffic control markings and legends shall be furnished and placed in accordance with all of the requirements given in Section 701 for Temporary Traffic Stripe except for the placement tolerances for length and width. The length of the markings and legends shall be no greater than 2 inches {50 mm} over or 1 inch {25 mm} under the required length. The width of the markings and legends shall be no greater than 1/2 of an inch {12 mm} over or 1/2 of an inch {12 mm} under the required width.

(c) Permanent Traffic Markings and Legends.

1. Applicator Applied Traffic Markings and Legends.

Permanent traffic control markings and legends shall be furnished and placed in accordance with all of the requirements given in Section 701 for permanent traffic stripe except for the following:

- Any type of equipment may be used that produces acceptable results;
- Class 2 thermoplastic shall be placed to produce a minimum uniform thickness of 0.125 inches {3.0 mm}.
- The length of the markings and legends shall be no greater than 2 inches {50 mm} over or 1 inch {25 mm} under the required length.
- The width of the markings and legends shall be no greater than 1/2 of an inch {12 mm} over or 1/2 of an inch {12 mm} under the required width
- Beads may be hand placed.

2. Preformed Traffic Markings and Legends.

a. General

All preformed traffic markings and legends shall be applied in accordance with the manufacturer's recommendations. Preformed thermoplastic may be applied to asphalt and concrete surfaces. Asphalt pavement shall be allowed to cure for a period of 14 calendar days before the application of the thermoplastic. Concrete pavement shall be allowed to cure for a period of 30 calendar days before the application of the thermoplastic. All preformed traffic markings and legends shall be a minimum uniform thickness of 0.125 inches {3.0mm}.

b. Surface Preparation Prior to the Application of Preformed Thermoplastic.

Areas to be striped shall be thoroughly cleaned of all dirt, oil and other debris in a way that will not damage the pavement surface.

Curing compound on concrete surfaces shall be removed by grinding, wire brushing, sand blasting or other effective means.

Striping shall not begin until the Engineer has inspected the pavement surface and has informed the Contractor that striping may begin.

c. Weather Conditions for the Application of Preformed Thermoplastic.

Preformed thermoplastic shall not be placed during rain or mist or if the pavement surface is wet. All preformed thermoplastic markings and legends shall be placed per the manufacturer's recommended directions. The Engineer shall be furnished a copy of these recommendations for installation inspection purposes.

d. Composition of Preformed Thermoplastic.

The preformed thermoplastic shall consist of high quality materials, pigments and glass beads or other reflective material uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other reflective material embedded in the top surface.

3. Specialty Traffic Markings and Legends.

Specialty Traffic Markings and Legends shall be placed where indicated on the plans and in accordance with the Special Drawings or plan details. Specialty Traffic Markings and Legends shall meet all of the requirements given in Subarticle 703.02(a) and Item 703.03(c)2.

(d) Retroreflectivity of Traffic Markings and Legends.

The white and yellow pavement markings shall attain an initial retroreflectance of not less than 250 mcd/lx·m2. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 250 mcd/lx·m2.

The Engineer will measure the retroreflectivity of emplaced preform thermoplastic material for each color at 5 random locations throughout the project selected in accordance with the requirements given in ALDOT Procedure 210.

If the average of the 5 retroreflectivity measurements is 85 % of the target retroreflectivity, or greater, the stripe will be accepted without a price adjustment for retroreflectivity.

If the average of the 5 retroreflectivity measurements is less than 85 % and greater than 50 % of the target retroreflectivity, the stripe will be paid for at a percentage equal to the percentage determined from the measurements. For example, if the average of the measurements is 65 % of the target retroreflectivity, payment for the stripe will be 65 % of the contract unit price.

If the average of the 5 retroreflectivity measurements is 50 % of the target retroreflectivity, or less, the stripe shall be removed and replaced without extra compensation.

Any portion of the stripe of the stripe that is determined by the Engineer to be noticeably inconsistent with the overall striping and measures less than 50 % of the target retroreflectivity shall be removed and replaced without extra compensation.

Retroreflectivity measurements will be made in accordance with the requirements given in ALDOT-422 with the exception of the sampling frequency. Measurements will be made between 7 and 30 calendar days after the completion of the placement of all stripe.

(e) Removing Markings or Legends.

The removal of traffic markings and legends shall be done in accordance with the requirements given in Section 701.

703.04 Method of Measurement.

The area of Traffic Control Markings or Legends (Items 703-A, 703-B, 703-H, and 703-I) complete in place and accepted will be the sum of the areas shown on the plans for each marking and legend constructed within the required placement tolerance.

The Removal of Traffic Control Markings or Legends (Item 703-C) shall be measured in the same manner as prescribed above except that it shall cover only the area from which the markings were actually removed.

The area of Temporary Traffic Control Markings or Legends, (Items 703-D and 703-E) complete in place and accepted, will be the sum of the areas shown on the plans for each marking and legend constructed within the required placement tolerance. No measurement for payment will be made for the removal of temporary markings or legends, the removal of such being classified as incidental to the Items of Temporary Traffic Control Markings and Temporary Traffic Control Legends.

703.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted square feet {square meters} of Traffic Control Markings or Legends, Items 703-A, 703-B, 703-H, and 703-I, measured as provided above, will be paid for at the contract unit price bid which shall be full compensation for the item complete in place and includes the cleaning of the pavement, furnishing and applying the markings or legends, and for all materials, equipment, tools, labor and incidentals necessary to complete the work.

The accepted square feet {square meters} of Traffic Control Markings or Legends Removed, Item 703-C, measured as provided above, will be paid for at the contract unit price bid which shall be full compensation for the item complete in place and includes traffic control for removal, all necessary materials, equipment, tools, labor and incidentals necessary to complete the work.

The accepted square feet {square meters} of Temporary Traffic Control Markings or Legends, Items 703-D and 703-E, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the item complete in place and includes the cleaning of the pavement, furnishing and applying the markings or legends, traffic control for placing, and for all materials, equipment, tools, labor and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

703-A Traffic Control Markings, Class ____ , Type ____ - per square foot {square meter}
703-B Traffic Control Legends, Class ____ , Type ____ - per square foot {square meter}
703-C Removal of Traffic Control Markings or Legends - per square foot {square meter}
703-D Temporary Traffic Control Markings - per square foot {square meter}
703-E Temporary Traffic Control Legends - per square foot {square meter}
703-H Specialty Traffic Control Markings – per square foot {square meter}
703-I Specialty Traffic Control Legends – per square foot {square meter}

SECTION 705
PAVEMENT MARKERS

705.01 Description.

This Section shall cover the work of furnishing and installing pavement markers of the Class and Type specified by the plans or proposal, at the locations designated on the plans or directed by the Engineer, all in conformity with the plans and these Specifications.

Pavement markers shall be divided into Classes and Types as noted.

Class "A" - Reflective markers.

Type 1 - Mono-directional.

1-A. 1 White reflector face with the marker body other than the reflector face shall be white, silver white or a neutral color.

1-B. 1 Yellow reflector face with the marker body other than the reflector face shall be yellow in color.

Type 2 - Bi-directional.

2-A. 2 White reflector faces with marker body other than the reflector faces shall be of a white, silver white, or a neutral color.

2-B. 1 White reflector and 1 yellow face with marker body other than the reflector faces shall be of a white, silver white, or a neutral color, or may be 1/2 yellow on the side with the yellow reflector and 1/2 white, silver white, or a neutral color on the side with the white reflector.

2-C. 1 White reflector and 1 red reflector face with the marker body other than the reflector faces shall be of a white, silver white, or a neutral color or may be 1/2 red on the side with the red reflector and 1/2 white, silver white or a neutral color on the side with the white reflector.

2-D. 2 Yellow reflector faces with the marker body other than the reflective faces yellow in color.

2-E. 1 Yellow reflector and 1 red reflector face with the marker body other than the reflector faces shall be yellow in color or may be 1/2 red on the side with the red reflector and 1/2 yellow on the side with the yellow reflector.

Class "A-H" - Reflective markers with hard, abrasion-resistant lens surface.

Type designations shall be as shown above for Class "A" markers.

Class "B" - Non-Reflective markers.

Type 1 - Ceramic.

1-A. White
1-B. Yellow
1-C. Black

Class "C" - Temporary markers.

Type 1 - Mono-directional.

1-A. 1 White reflector face
1-B. 1 Yellow reflector face

Type 2 - Bi-directional.

2-A. 2 White reflector faces
2-B. 1 White and 1 Yellow reflector face
2-C. 1 White and 1 Red reflector face
2-D. 2 Yellow reflector faces
2-E. 1 Yellow and 1 Red reflector

705.02 Materials.

Materials furnished for use shall comply with the appropriate requirements of Division 800, Materials, with special attention directed to Section 882.

The Department has established List V-2, Permanent Pavement Markers, Temporary Pavement Markers, Marker Adhesive, Delineators and Hazard Markers. This list is in the Department’s Manual, “Materials, Sources, and Devices with Special Acceptance Requirements”. Only the materials on these lists shall be furnished for use. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

705.03 Construction Requirements.

(a) General.

Equipment shall include an automatic mixing and metering machine capable of preparing a machine type adhesive meeting the requirements of Article 882.04 and metering the amount of adhesive required to affix each marker to the pavement.

The procedure for installing the markers shall be that of the Contractor provided such is within the scope of the installation procedure recommended by the manufacturer of the marker and such is demonstrated to be operable and that the markers are firmly affixed to the surface in such a manner that they will not be displaced under traffic; the entire bottom surface shall be coated with adhesive.

The installation of the markers shall be such that the color of the marker housing is compatible with the color of the traffic stripes they are to supplement or replace.

Reflective pavement markers shall be placed at the designated location in such a way that the color of the reflected light is in accordance with the plan details or as directed by the Engineer.

The portions of the highway surface to which the marker is to be attached shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement or any other material which might affect the attachment of the marker to the pavement, with the area to which the marker is to be affixed prepared by sand blasting immediately prior to placement of the marker.

The general locations of the pavement markers will be indicated by the plan details or directed by the Engineer. The Contractor shall provide all engineering services necessary to premark and lay out the markers in accordance with the plan details. The Contractor shall submit to the Engineer for approval three copies of a report of survey which clearly indicates the locations for the various types of markers to be used along with spacing, pattern, etc. specified by the plan details. Said report shall be submitted at least two weeks prior to beginning placement operations. Upon acceptance and approval of the report data the Engineer may waive the two week time period noted above. Note is made of the fact that obtaining approval of the above noted report is considered incidental to the work and no time extension or time delay will be considered due to failure to obtain approval of the report.

After placement of any temporary markers, the Contractor shall maintain them, at his expense, in such a manner as to provide good, definite delineation during hours of both daylight and darkness until (1) they are overlaid by a subsequent pavement layer, or (2) they are removed as directed by the plans or the Engineer, or (3) in case of a detour road, until traffic is removed from the detour.

(b) Public Convenience and Clean Up.

The road may be fully open to public travel during the progress of work under this Section. Hence, when work is to be performed under traffic, the Contractor shall operate his equipment and store his materials and supplies in such a manner as to cause a minimum of inconvenience to the traveling public.

Upon completion of the work under this Section any damage to the pavement or other facilities caused by the operation or the Contractor's equipment, shall be repaired by the Contractor as directed without additional cost to the State.

705.04 Method of Measurement.

Pavement Markers installed as directed and accepted will be measured by counting separately the number of various class and types of markers provided by the plans or proposal.

705.05 Basis of Payment.

(a) Unit Price Coverage.

The number of Pavement Markers measured as noted above will be paid for at the respective contract unit price bid for each class and type specified by the plans or proposal. Said contract unit prices bid shall be full compensation for furnishing and installing the pavement markers, removing pavement markers (if required), and for all materials, equipment, labor and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

705-A Pavement Markers, Class ____ , Type ____ - per each

SECTION 707
DELINEATORS AND OBJECT MARKERS

707.01 Description.

This Section shall cover the work of furnishing delineators and object markers and the installation of such at the locations designated on the plans or directed, in conformity with the plans and these specifications.

Delineators will be classified by the "type" installation in accordance with plan details, which set forth details of various types of delineator installation. All delineators will be mounted on posts except as shown on the plans or detailed hereinafter.

At those locations shown on the plans or directed by the Engineer, delineators meeting the requirements specified hereinafter or on the plans shall be mounted on guardrail. All old delineators shall be removed and disposed of in a manner acceptable to the Engineer.

Also at those locations shown on the plans or directed by the Engineer, delineators meeting the requirements specified hereinafter or on the plans shall be mounted on barrier rail.

Object Markers will be classified according to the type of installation, in accordance with plan details. Object markers may be composed of sign panel and/or reflectors with backing panel, mounted on posts or highway structures.

Object Markers shall also include reflective safety markings applied on roadway objects and bridges in accordance with the details shown on the plans or directed. These object markers shall include:

- Marking an area with alternate diagonal stripes of reflective yellow and a stripe of a non-reflective material. The size of the area and the width and slope of the stripes along with the reflective color will be shown in the detailed plans or directed by the Engineer.
- Marking an area with reflective white or silver-white material. The size and shape of the area of coverage will be shown in the detailed plans or directed by the Engineer,

707.02 Materials.

(a) Delineators.

Materials furnished for use shall be new, complying with the appropriate sections of Division 800, Materials. Special reference is made to Section 881.

If the hardware used to secure an old delineator is in a condition acceptable to the Engineer, the Contractor, at his option, may use the old hardware in lieu of new hardware when mounting guardrail mounted delineators, Item 707-C.

The Barrier Rail Mounted Delineators and mounting hardware shall be new and shall be furnished and maintained in accordance with the details shown on the plans. The delineators shall have a minimum rectangular reflective area of 3 inches wide by 4 inches tall {75 mm inches wide by 100 mm tall}.

(b) Applied Reflective Materials for Object Markers.

The reflective material furnished for use shall be capable of readily adhering to various types of material especially concrete, steel, and wood, and capable of being applied by brush, spray, silk screen or other acceptable methods. The reflective material shall be capable of being applied in one application, that is, the addition of another material such as beads to produce the required reflectivity will not be acceptable.

Reflective requirements when tested by the procedure outlined in paragraph 4.4.7 of Federal Specifications LS-300A shall be as follows:

COEFFICIENT OF RETROREFLECTIVITY candlepower/footcandle/square foot {candelas/lux/m²}							
		Color					
		White or Silver-White #1		White or Silver-White #1		Yellow	
Incident Angle	Divergence Angle	.2	.5	.2	.5	.2	.5
- 4		20	10	40	20	10	5
- 40		7	4	11	8	3	3

Test panels of the materials shall be submitted for evaluation of the reflective capabilities by the Testing Engineer. Test panels shall be square, 12 inches X 12 inches {300 mm by 300 mm}, and shall be made of aluminum prepared with a good quality of white exterior primer. The reflective material shall be applied at the manufacturer's recommended wet film application rate and such rate shall be noted on the back of the test panel.

Drying time of the material shall be such that the surface treated shall be dust free within 10 minutes and dry to touch within 30 minutes after application.

Durability of the material shall be such that no appreciable discoloration, cracking, crazing or blistering occurs and at least 80% of the specified reflective requirements is retained after exposed for 1200 hours to Atlas twin arc weathering in accordance with ASTM D 822.

(c) Applied Non-Reflective Material for Object Markers.

The non-reflective material furnished for use shall be a flat black color meeting one of the following requirements:

1. Comply with the requirements noted in Subarticle (a) above except that there will be no reflective requirements and the material shall have a gloss reading of less than 20 units at an angle of 45° when measured with a photovoltmeter or a meter capable of giving equal results.
2. Comply with the following requirements:
   a. Capability of readily adhering to a concrete surface.
   b. Provide a uniform high degree of hiding power with one application.

c. Tests:

Total Solids	50 Min.	FSS-4041
Weight {Mass} per gallon {liter}	9 pounds {1 kg} Min.	FSS-4184
Viscosity	60 KU Min. - 80 KU Max.	FSS-4281
Dry Time	8 hrs. Max.	FSS-4061 with 0.0025 inches {0.06 mm} wet film
Fineness of Grind	4 Min.	Hegman Scale
Gloss Reading	20 units @ 45° Max.	Photovoltmeter or equivalent

(d) Flexible Delineator Post with Base and Raised Curb Channelizer.

Flexible delineator posts with bases and raised curb channelizers shall be furnished in compliance with the requirements of Division 800, Materials and the requirements shown on the plans. A list of acceptable products is given in List IV-4, Miscellaneous Traffic Control Devices in the MSDSAR.

707.03 Construction Requirements.

(a) Delineator Installations.

1. Erecting Posts.

The posts for the delineators shall be set at the locations shown on the plans and as directed by the Engineer. Posts shall be erected to a true vertical position. Any post damaged or otherwise unsuitable for the work shall be removed and replaced by the Contractor at his expense. Posts shall be inserted into the ground to a depth of not less than 24 inches {600 mm}.

Posts may be driven where this can be done without damage to the posts or galvanization. Otherwise, at the Contractor's election, posts shall be set in a 6 inch {150 mm} diameter drilled hole and backfilled with sand and thoroughly flooded with water to insure compaction. This backfill shall extend up to the existing ground elevation, or the Contractor may use poured concrete in lieu of sand. If solid rock is encountered, holes shall be drilled and backfilled with concrete to the top of the rock or as directed.

Concrete for setting posts shall be Class A concrete complying with applicable portions of Section 501, with the following modifications:

- The concrete may be dry batched at a central mixing plant and delivered to the project. Before the concrete is placed water shall be added. This may be done in small amounts as needed and mixed on a mixing board or in a mortar box. After water is added, the mix shall be used within sixty (60) minutes. Posts shall be held in proper position until the concrete hardens. The concrete shall have cured for 72 hours before any strain is placed on the post.
- Test cylinders for the concrete will not be required.

Where posts are required to be set in concrete medians, holes approximately 6 inches {150 mm} in diameter may be drilled or square holes approximately 6 inches by 6 inches {150 mm by 150 mm} may be cut or formed during placing of the concrete median. The posts shall be set by driving or other approved means, to a depth of not less than 24 inches {600 mm} below top of the median and to such greater depth as may be required to erect the delineator at the required elevation, above the pavement. After the post has been set, the hole up to the bottom of the pavement shall be backfilled and compacted; the hole for the depth of the median pavement shall then be filled with one of the appropriate bituminous plant mixes provided in the Specifications.

2. Attaching Delineators.

After erection of the delineator posts as noted, the delineators shall be affixed to the post in the manner shown on the plans.

3. Guardrail Mounted Delineator.

The delineators shall be acceptably affixed to the guardrail in the manner shown on the plans. Old or reconditioned hardware may be used only with the approval of the Engineer. All delineators shall be new.

4. Barrier Rail Mounted Delineator.

The delineators shall be acceptably affixed to the barrier rail in the manner shown on the plans. The delineators shall be installed at a maximum spacing of 40 feet {12.2 meters} between each delineator or at a closer spacing if shown on the plans or directed by the Engineer.

5. Flexible Delineator Post with Base.

A flexible delineator post with base shall be installed according to the manufacturer's recommendations.

6. Raised Curb Channelizer.

A raised curb channelizer shall be installed according to the manufacturer's recommendations.

(b) Object Marker Installation.

1. Erecting Posts.

Posts, when required, shall be installed in the same manner prescribed in Subarticle (a) for delineator posts modified to cover embedment depth of posts shown by plan details.

2. Attachment of Markers and Panels.

After erection of posts, when required, markers and panels shall be affixed to posts or structures as required in accordance with the details shown on the plans.

(c) Object Marker Installation with Applied Materials.

1. Preparation of Surface.

The surface directed to be treated shall be clean, dry and free of any loose laitance or foreign material. Cleaning may be accomplished by the use of soap and water, cleaning solvent, wire brushes or other acceptable means which will produce the desired results.

2. Application of Reflective and Non Reflective Material.

The material may be placed by brush, spray, silk screening or other means consistent with the recommendations of the manufacturer which will produce the desired results.

(d) Public Convenience and Final Cleanup.

The road may be fully open to the public travel during the progress of work under this section. Hence, when work is to be performed under traffic, the Contractor shall operate his equipment as well as store materials and supplies in such a manner as to cause a minimum of inconvenience to the traveling public. Special attention is directed to Article 107.07.

Upon completion of the work under this Section, the Contractor shall remove all surplus and waste material caused by this work and shall restore the area to at least the same condition as was existing prior to commencing of the work. Any damage to slopes, pavement, etc. caused by the operation of the Contractor's equipment shall be repaired as directed without additional cost to the Department.

Prior to completion of the project, the Contractor shall clean the installed delineators, when directed by the Engineer, without additional cost to the Department.

707.04 Method of Measurement.

Delineator Installations installed as directed and accepted will be measured by counting separately the number of a particular type or types of delineator installations provided by the plans or proposal.

Guardrail mounted delineator, installed as directed and accepted, will be measured per each for the number installed.

Barrier rail mounted delineator, installed as directed and accepted, will be measured per each for the number installed. There will be no measurement of delineators that the Contractor must install to replace damaged or missing delineators.

Object Marker Installations installed as directed and accepted will be measured by counting separately the number of a particular type or types of object marker installations provided by the plans or the proposal.

Flexible delineator post with base will be measured per each for the number installed. There will be no measurement of posts or bases that the Contractor must install to replace any that are damaged or missing

Raised curb channelizer will be measured per linear foot for the quantity installed. There will be no measurement of posts or curb that the Contractor must install to replace any that are damaged or missing.

For Object Marker Installations with Applied Materials, the actual area ordered and accepted will be computed in square feet {square meters} to the nearest square foot {0.1 m^2} from measurements taken on the surface of the prepared area.

707.05 Basis of Payment.

(a) Unit Price Coverage.

The number of the particular type of Delineator Installations ordered and accepted, measured as noted above, will be paid for at the respective unit prices bid for each type installation, Said unit price bid shall be full compensation for furnishing and installation of the delineators complete in place, including posts, hardware, brackets, braces and all materials, equipment, tools, labor and incidentals necessary to complete the work.

The number of guardrail mounted delineator installations, ordered and accepted, measured as noted above, will be paid for at the respective unit price bid for each delineator and shall be full compensation for furnishing, installing, and cleaning the delineators complete in place, including all hardware, delineators, materials, equipment, tools, labor, including the removal of old delineators, reconditioning of hardware and all incidentals necessary to complete the work.

The number of barrier rail mounted delineator installations, ordered and accepted, measured as noted above, will be paid for at the respective unit price bid for each delineator and shall be full compensation for furnishing, installing, and cleaning the delineators complete in place, including all hardware, delineators, materials, equipment, tools, labor, and all incidentals necessary to complete the work.

The number of the particular type of Object Marker Installations ordered and accepted, measured as noted above, will be paid for at the respective unit prices bid for each type installation. Said unit price bid shall be full compensation for furnishing and installing the Object Marker Installation complete in place, including post or anchors as required by plan details, hardware, brackets, braces and all materials, equipment, tools, labor and incidentals necessary to complete the work.

The number of flexible delineator posts with bases ordered and accepted, measured as noted above, will be paid for at the unit price for installation. This price shall include the post, base, anchors, hardware, and all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Raised curb channelizers, measured as noted above, will be paid for at the unit price for installation. This price shall include the posts, curb, anchors, hardware, and all materials, equipment, tools, labor, and incidentals necessary to complete the work.

The area of Object Marker Installations with Applied Materials measured as noted above will be paid for at the respective contract unit price bid for the various types of markings complete in place. Said unit price bid shall be full compensation for furnishing all materials, cleaning and preparation of the surface, application of the materials and for all labor, tools, equipment and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

707-A Type ____ , Color Delineator Installation - per Each
707-B Type ____ Object Marker Installation - per Each
707-C Guardrail Mounted Delineator - per Each
707-F Flexible Delineator Post with Base, Color – per each.
707-G Barrier Rail Mounted Delineator (*) - per Each
707-H Raised Curb Channelizer, Color – per linear foot.
707-I Object Marker Installation with Applied Materials (Striped or Reflective White) – per square yard

* Specify "Mono-directional", "Bi-directional", etc.

SECTION 709
MILE {KILOMETER} POSTS

709.01 Description.

The work under this Section shall cover furnishing and erection of mile {kilometer} post assemblies in accordance with the details shown on the plans and the following specifications.

The mile {kilometer} post, consisting of a mile {kilometer} marker mounted on a suitable post, shall be classified under one of the following types:

Type A: Consists of a single post with one mile {kilometer} marker mounted on the post with the marker facing the oncoming traffic.

Type B: Consists of a single post with two mile {kilometer} markers mounted back to back on the post so as to be seen by traffic in each direction.

In general, the mile {kilometer} posts will be established for the Federal and State Highways beginning at the south or west State Line, or at junctions where routes begin. The mile {kilometer} posts will then proceed continuously north and east along the routes through the State.

709.02 Materials.

Materials furnished for use under this Section shall comply with the requirements of Article 710.02, the detailed plans and the following:

- Sign panels shall be limited to aluminum with reflective sheeting.
- Posts shall be of the type designated on the plans. If the plans offer a choice and once this choice is made and erection begun, the Contractor will not be permitted to change to another type without written permission of the Engineer.

Reset units shall utilize existing material insofar as possible. Any replacement parts necessary shall comply with the requirements specified above in this Article.

709.03 Construction Details.

Construction details shall be as follows:

All signs shall be erected and supported in accordance with these specifications and as shown on the plans. Horizontal edges of signs shall be level and faces of signs shall be vertical.

The Engineer will mark the location and designate the numerical number for each mile {kilometer} post.

If man-made obstructions are encountered at the measured marker location (such as underground obstructions), the Engineer may direct one of the following:

1. Shifting of the mile {kilometer} post location not to exceed 50 feet {10 m} either forward or backward to a more suitable location.
2. If underground obstructions occur which cannot be by-passed by the method noted next above, the Engineer may order the deletion of the mile {kilometer} post from the contract.

However, regardless of which of the two methods noted above are used, no more than one marker may be omitted and the succeeding mile {kilometer} post shall be located, based on the established mile {kilometer} post location and not on any adjusted location.

If current construction in progress is at such a stage to warrant delaying installation, the Engineer may direct the delivery of the complete mile {kilometer} post assembly to the District Engineer's office. Under this condition, payment for the mile {kilometer} posts will be made in accordance with the provisions of Subarticle 109.06(b) of the Standard Specifications.

As soon as the work begins, it shall be prosecuted continuously until the work is complete.

Positioning of the mile {kilometer} post relative to the pavement or shoulder edge shall be as shown on the plans.

After installation of the posts and checking for position (horizontal and vertical), the sign faces shall be secured to the posts in the manner provided by the plans.

No sign posts shall be left standing without a sign face after daylight hours unless warning markers, reflectors, etc., are provided to warn the traveling public. In the same manner, no holes or other hazardous condition shall be left without proper warning markers and delineation.

The Contractor shall be responsible for any damage done to the signs or posts which occur from any cause prior to acceptance as mentioned in Article 709.05. Signs and posts are to be stored under cover and protected from the weather and other damage until they are erected.

Mile {kilometer} post assemblies designated to be reset shall be carefully removed and reinstalled at the designated new location. Removal methods will, in general, be at the option of the Contractor provided such does not damage the assembly. Any damage caused by the Contractor's operation or on account of carelessness negligence, loss of materials or failure to conduct the work properly shall require replacement in kind at no additional cost. Reinstallation shall be in the same manner as for new installation as noted above in this Article.

709.04 Public Convenience and Safety.

The Contractor's attention is directed to Article 107.07 and the following:

No highway will be closed to traffic for the purpose of erecting mile {kilometer} posts. The Contractor will be required, without extra compensation, to provide adequate and acceptable warning signs, temporary guide markers and/or flagmen for directing traffic during working hours. All of the above shall be in accordance with Part VI of the current MUTCD.

Traffic may be shifted to one 12 foot {3.6 m} lane, allowing the Contractor temporary use of one 12 foot {3.6 m} lane for the loading and unloading of materials. No loading or unloading of any kind will

be permitted along the lane or lanes designated for highway traffic, nor will equipment be allowed to traverse roadways or lanes against normal traffic flow.

In addition, should the Contractor's equipment damage the shoulders, ditches, slopes or pavement during the performance of this work, he shall restore said areas to the original condition without cost to the State.

709.05 Acceptance of Contracts for Mile {Kilometer} Posts Only.

As soon as the installation of all mile {kilometer} posts on a route to be marked has been completed in accordance with the plans and specifications and to the satisfaction of the Engineer, the Engineer may make final acceptance of such work. After final acceptance of the mile {kilometer} posts on a particular route has been made, the Contractor will be relieved of any further maintenance of the mile {kilometer} posts for that particular route. Final acceptance of the entire contract will be made as soon as all work required by the contract has been completed and accepted.

709.06 Method of Measurement.

The measurement of Mile {Kilometer} Posts will be made for the actual number of complete mile {kilometer} post assemblies of each designated type, installed complete in place.

The measurement of Mile {Kilometer} Posts Reset will be made for the actual number of complete mile {kilometer} post assemblies, regardless of type, removed and reinstalled, complete in place.

709.07 Basis of Payment.

(a) Unit Price Coverage.

The accepted Mile {Kilometer} Posts, furnished as directed and measured as noted above, will be paid for at the respective contract unit price bid for each of the items of the contract, which shall be full compensation for the furnishing and processing of all materials, fabrication, erection and assembling or assembly and delivery to the designated location, transportation, including excavation, backfilling and incidentals necessary to complete the work.

The accepted Mile {Kilometer} Posts Reset, measured as noted above, will be paid for at the contract unit price bid, which shall be full compensation for the removal and reinstallation of the mile {kilometer} post assembly which includes preparation of the new area, restoration of the area, disposal of any surplus or excess material and for all equipment, tools, labor, and any miscellaneous hardware and materials or incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

709-A Mile {Kilometer} Post, Type ____ - per each
709-B Mile {Kilometer} Post}, Reset ____ - per each

SECTION 710
ROADWAY SIGNS

710.01 Description.

(a) General

This Section shall cover the work of furnishing and erecting roadway signs of the various types, sizes, wording, marking, etc., detailed by the plans in accordance with the latest edition of the MUTCD except as modified herein or by the plan details. The type and number of signs, sign supports, backing frames when required, foundations and reflectorization to be furnished and installed shall be as detailed on the plans. Concrete foundations, when required, shall be constructed as shown on the plans or as directed by the Engineer.

(b) Types and Classes of Signs

The items of work for Roadway Signs will indicate whether the sign is of a reflectorized or non-reflectorized type, and the kind of backing material.

Sheeting used in the fabrication of sign faces shall be one of the following types unless required otherwise on the plans or in the proposal:

TYPES AND DESCRIPTIONS OF SIGN SHEETING	
Type I	Medium-intensity retroreflective sheeting, "engineering grade"
Type I-N	Non-reflective sheeting
Type II	Medium-high-intensity retroreflective sheeting, "super engineering grade"
Type III	High-intensity retroreflective sheeting
Type IV	High-intensity retroreflective sheeting, "microprismatic"
Type V	Super-high-intensity retroreflective sheeting, "microprismatic"
Type VI	Elastomeric high-intensity retroreflective sheeting without adhesive, "microprismatic"
Type VII	Sheeting previously classified as Type VII has been reclassified as Type VIII. The designation of Type VII has been discontinued. (ASTM D 4956-09)
Type VIII	Super-high-intensity retroreflective sheeting (ASTM D 4956 Table 2) , "microprismatic"
Type IX	Very-high-intensity retroreflective sheeting, "microprismatic"
Type X	Sheeting previously classified as Type X has been reclassified as Type VIII. The designation of Type X has been discontinued. (ASTM D 4956-09)
Type XI	Super-high-intensity unmetalized cube corner microprismatic retroreflective sheeting. (ASTM D 4956-09, Table 10)

CLASSES AND DESCRIPTIONS OF SIGNS	
Class 1	Obsolete
Class 1A	Obsolete
Class 2	Type IV Reflectorized Sheeting Background with the same Type Reflectorized Sheeting Cut-Out Copy
Class 2A	Type IV Reflectorized Sheeting Background with Non-Reflectorized Cut-Out Copy For Multiple Extruded Panels, Type XI Reflectorized Sheeting Background with Digital Printing is also allowable.
Class 3	Obsolete
Class 4	Type IV Reflectorized Background with Screen Copy
Class 5	Type IV Reflectorized Sheeting Background with Screen Copy
Class 6	Type IV Reflectorized Sheeting Background with Type XI Reflectorized Sheeting Cut-out Copy For Multiple Extruded Panels, Type XI Reflectorized Sheeting Background with Digital Printing is also allowable.
Class 7	Type IV or XI Reflectorized Sheeting Background with Screen Copy. Type XI Reflectorized Sheeting with Digital Printing is also allowable.
Class 8	Obsolete
Class 9	Type XI Reflectorized Sheeting Background with the sameType Reflectorized Sheeting Cut-Out Copy or Digital Printing.
Class 10	Type XI with Screen Copy or Digital Printing

When the Contractor has the choice of selecting the sheeting Type within a respective Class, the mixing of different sheeting types on signs on the same project will not be allowed unless shown otherwise on the plans or in the proposal.

(c) Methods of Fabrication.

In addition to the Classes noted above, signs will be designated by the method of fabrication as follows:

1. Flat Panel.

A sign face which can be fabricated from a single sheet of material normally not in excess of 4 feet {1200 mm} in width.

2. Multiple Flat Panel.

A sign face which because of size can not be fabricated from a single sheet of material. These panel sections shall be fabricated from sheets not less than 4 feet {1200 mm} in width, except that only one sheet for any one sign may be cut to less than 4 feet {1200 mm} in width to fabricate signs which are not multiples of 4 feet {1200 mm} in width. Multiple flat panel sign sections shall run from top edge to bottom edge of sign face without horizontal joints, except that signs greater than 11 feet {3.4 m} in height may have a horizontal joint but no sign shall have more than one horizontal joint.

The use of material sheets of greater width than the minimum 4 feet {1200 mm} noted to form sign panels will be acceptable; however, the backing, support, etc. must conform to the plan requirements for this classification of panel.

All panel joints shall be provided with backing strips firmly affixed to the sign to keep the panel sections in proper alignment as detailed on the plans.

3. Multiple Extruded Panels

Multiple panel signs may be made of extruded sections. All extruded sections shall be 12 inches {300 mm} wide mounted horizontally and shall have no vertical joints. All panels shall be flat and straight. Multiple extruded panel signs shall be limited to Class 6 and Class 2A signs. Exceptions will be made to allow 6 inch {150 mm} wide extruded sections in cases where the height of a sign or exit panel dictates. There shall not be more than one 6 inch {150 mm} wide panel allowed per individual sign or exit panel.

710.02 Materials.

All materials furnished for use shall comply with the appropriate requirements of Division 800, Materials, and the requirements noted herein in this Section. Special reference is made to Section 880 for Sign Materials, Section 501 for Concrete, Section 502 for Steel Reinforcement, and Section 508 for Structural Steel.

Sampling and inspection of sign materials will be done in accordance with the requirements given in ALDOT-245, "Procedures for Sampling and Inspection of Roadway Signs and Overhead Sign Structures."

Design drawings covering details for legend and message layouts for sign panels will be shown on the plans.

Any deviation from details shown in the plans or furnished the successful bidder must be approved by the Engineer.

Letter series shall meet the requirements of the MUTCD, unless otherwise provided by plan details.

Unless otherwise noted by plan details, signs shall meet Standard Highway Sign sign blank standards or shall have rounded corners. For guide signs square corners are allowed, but the border shall be rounded to the radius shown in the plans.

In the event the plans do not contain a detailed layout for a specific sign, such as a route marker, the layout shall be as approved by the Engineer.

710.03 Construction Requirements.

(a) General.

1. All signs shall be erected and supported in accordance with these specifications and as shown on the plans. Horizontal edges of sign shall be level and faces of signs shall be vertical.

2. After being authorized by the Department to proceed with the work, the Sign Contractor shall be required to begin with the erection of signs, on that portion of the project that, as determined by the Engineer, will best serve the traveling public.

In most instances sign work will of necessity be performed while the roadway is open to traffic. It is not intended that any section of road be left unmarked or in a hazardous condition; therefore, the Contractor shall plan his operation in such a manner as to accomplish the following, all of which shall be considered an integral part of the work required under this section.

a. Work shall be performed in such a manner as not to be hazardous to the traveling public.
b. Existing signs shall not be removed until the new replacement signs are installed and completed.
c. No sign posts, particularly adjacent to the shoulders, shall be left standing without a sign face after daylight hours unless warning markers, etc. are provided to warn the traveling public. In

the same manner no holes or other hazardous condition shall be left without proper warning markers or delineation.

d. Once the work of installation of a sign structure is begun, the work shall be diligently prosecuted until its completion.

3. When a section of a project is completed to the state of use, the Contractor may be required to begin erection of signs within ten days after receipt of notice from the Engineer, even though the work on the roadway may not be completed and accepted by the State.

4. The contractor shall be responsible for any damage done to signs or posts which may occur from any cause, save an unavoidable natural cause, until the work is complete and accepted by the State. Signs and posts are to be stored under cover and protected from the weather and other damage until they are erected.

5. The plans indicate the extent and general arrangement of signs. The plans are to be used for the general guidance of the Contractor and any commission or omission shown or implied shall not be the cause for deviating from the intent of the plans and specifications. If any departures from the plans and specifications are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer for approval. The decision of the Engineer shall be final and mandatory.

(b) Staking Out Signs.

The Contractor shall not order posts until the length has been established in the field. If Geometric Controls are not set up, the Engineer shall stake out the location of each sign along the work. The Contractor, however, will be required to check all dimensions and clearances measured from such stakes and shall thereafter become responsible for orientation, elevation, offset and level of all signs erected. If Geometric Controls are set up, the contractor shall stake out the location of each sign along the work. The Contractor shall not order posts until the Engineer has reviewed the sign locations as staked. The Contractor will be required to provide all dimensions and clearances measured from such stakes and shall thereafter become responsible for orientation, elevation, offset and level of all signs erected

Where beam posts are required the contractor shall set foundations and verify post lengths before ordering posts. No foundations shall be mounded to compensate for beam posts which are too short.

(c) Positioning of Sign Faces.

Positioning of sign faces shall be such as to eliminate or minimize specular (mirror like) reflection and provide maximum readability.

Ground mounted signs shall be erected so that the face is truly vertical and at an angle to the roadway centerline as detailed by the plans unless otherwise directed by the Engineer. On curves, sign faces shall be oriented so as to be most effective, both day and night, to avoid specular reflection.

Overhead signs shall be erected so that the sign face is at the vertical angle with the roadway indicated by the plans or directed and is in the proper position over designated traffic lanes.

All sign panels shall be so mounted that the tops of panels or the messages on shaped panels are truly horizontal. Vertical and horizontal positioning of sign faces shall be as detailed by the plans or directed to provide the clearance and height required by MUTCD or noted on the plans.

(d) Installation of Ground Mounted Sign Supports.

1. General.

The size, number and type of supports shall be shown on the plans. The support shall not extend above the sign panel, but in no case shall the support be less than 3 inches {75 mm} above the uppermost stringer mounting bolt. Cutting steel supports to length after they have been galvanized will be permitted provided the cutting is limited to sawing and the damaged area is regalvanized as shown on the plans or directed.

2. Erection of Posts.

a. General.

Posts shall be installed as indicated by plans. The length of the posts or supports shall be determined as noted in this Section.

Installation shall be accomplished in such a manner that the entire post is installed as one unit, unless shown otherwise by the plans, to insure proper alignment, etc. of the post. All posts shall be checked with a spirit level for vertical alignment. Posts with breakaway features may be adjusted

slightly by the use of special shims as indicated by plan details; major adjustments shall require removal and resetting.

When breakaway features are incorporated into post assemblies, the requirements noted in this Item shall be complied with to insure their functioning properly under field conditions.

Tubular posts, after installation, shall be provided with a proper cap. Caps may not be required for perforated tubular posts.

b. Foundations.

When foundations require the use of concrete encasements, the posts shall be installed in pre-dug holes and backfilled with Class A concrete. Reinforcement, if required, shall be as detailed on the plans.

When plans and soil conditions permit the installation of posts by driving, a method of driving will be required that will not damage the posts. Any damage in driving shall be cause for rejecting the post and requiring it to be replaced. In lieu of driving, the Contractor may elect to install the posts by pre-dug holes and backfilling with sand. The sand backfill shall be thoroughly flooded with water to insure good compaction. If solid rock is encountered, the posts shall be placed in drilled holes and backfilled with concrete to the top of the rock as shown on the plans or directed and the remainder backfilled as noted above.

c. Breakaway Features.

(1) General.

Unless otherwise noted in the detailed plans, all bolts, nuts and washers used in the breakaway features shall be High Strength galvanized complying with the requirements of Article 836.33.

The functioning of the breakaway design is dependent upon the proper installation of these bolts so that the residual tension specified by the plans is obtained. To accomplish this, the following requirements shall apply:

All bolts, nuts and washers of each diameter bolt required in the work shall be from the same manufacturer. Bolts used in each type connection (hinge, fuse or base) shall be so sized that all bolts for a particular type connection in a support structure are of the same length. Said length shall be the minimum plan specified length plus any additional length necessary to provide at least two exposed threads on the bolt after the connection has been properly tightened.

The torque necessary to obtain the residual bolt tension required by the plans shall be determined by a "bolt-tension calibrator." The Department will provide the "bolt-tension calibrator" for calibration of the Contractor's torque wrench for the various sizes of bolts.

The Contractor shall supply five sets of bolts, nuts and washers of each diameter to be used in the work for determination of the bolt torque necessary to obtain the residual bolt tension specified by the plans.

(2) Setting of Bolt Tension.

All posts and sign panels shall be in place prior to setting of the bolt tension for the base connections and the post fuse and hinge plates.

After completion of the sign panel installation, all bolts, nuts and washers used in the hinge plates, fuse plates and base connections during the shipping and installation of the support assembly shall be removed and replaced with approved High Strength bolts, nuts and washers.

Prior to use of the H.S. bolts, etc. they shall be checked to insure they are free turning and are lubricated with a bee's wax based lubricant approved by the Engineer (some commercial wax products have proven satisfactory). Installation of the bolts, etc., may then proceed using the appropriate calibrated torque wrenches for the size bolt being installed. All lubricating and torquing of the H.S. bolts and nuts shall be performed in the presence of an inspector. Any bolt not installed in the presence of an inspector shall be removed and examined to insure the nut is free turning for the full thread length (any binding shall be cause for rejection), lubricated and re-installed as noted.

Setting of bolt tension may be achieved without the use of a torque wrench if special hardware is provided by the manufacturer of the approved breakaway device. The bolt hardware must be designed with an integral means for tightening the bolts to the required tension.

(e) Erection of Framework and Sign Panels.

Framework for erecting sign panels shall be assembled and attached to the ground supports as provided on the approved drawings. All horizontal members of supporting frames shall be truly horizontal and at correct height so that the bottom of the sign shall be at the height above pavement specified and proper horizontal position.

Erection of sign panels shall be done in a neat and workmanlike manner. Sign panels shall be attached to the supporting frames in accordance with the recommendations of the sign panel manufacturer. All nuts, bolts, screws and set screws shall be tightened securely.

Signs shall be inspected at night by the Engineer, and if specular (mirror like) reflection is apparent on any signs, its positioning shall be adjusted by the Contractor.

When sign panels are noted to be re-installed on another support assembly, removal of the old panel from its supports shall be done in such a manner as to prevent damage to the panels; remounting shall be accomplished in the same manner noted for new panels. The use of dismantled hardware in remounting of the old panels is allowed; however, if the old hardware is unusable, the Contractor shall provide the appropriate new hardware necessary to install the panel.

(f) Removal of Existing Signs.

The Contractor shall dismantle and remove all existing signs designated to be removed; however, when they are to be replaced with another sign, the new sign shall be in place before the old sign is removed unless otherwise ordered by the Engineer.

Unless noted otherwise on the plans, the Contractor will be allowed to keep all sign panels that are designated for removal.

All materials to be retained by the State (panels, supports and hardware) shall be removed in such a manner as to prevent undue damage and the materials stacked and stored at a site on the project designated by the Engineer, for later pickup by others. Care shall be taken during removal, handling and storage to protect the treated surfaces; especially sign faces; hardware shall be bagged or boxed; posts, especially those with breakaway features, shall be removed so that the bases are kept intact insofar as practical. Any damage to or loss of removed materials due to negligence on the part of the Contractor's removal methods shall be cause for ordering replacement in kind for the damaged or lost items.

Any posts or mounting supports to be removed shall either be pulled or removed or, at the discretion of the Contractor, cut off and removed to a depth of not less than 1 foot {0.5 m} below the actual ground surface and the area backfilled with suitable material. The area shall be cleaned and dressed out in a manner consistent with the surrounding area.

(g) Cleanup of Area.

The Contractor shall be required to remove all rejected and unused materials and debris from the right of way. The contractor shall restore shoulders and slope, including grass, to the original condition. Excess excavation will be disposed of off the right of way at the Contractor's expense, unless otherwise authorized by the Engineer, and other cleaning up as may be necessary to insure the effectiveness and neat appearance of the work.

(h) Inspections.

Attention is directed to the fact that sign panels as well as supports must be approved before installation will be permitted.

In addition to normal inspections attention will be directed to inspection of the unit after installation to insure that any damage caused by the installation operation or any defect which will affect the serviceability is promptly corrected.

Attention is directed to the special inspection requirements noted in Subitem 710.03(d)2c when setting base plate, hinge plate and fuse plate bolt tensions.

710.04 Method of Measurement.

Completed and accepted Sign Face Panels will be measured in square feet {square meters} between the outside edges of the signs (includes frame and border).

Installed and accepted posts will be measured in feet {meters} which will be the entire length of the installed post from tip to tip and includes any breakaway feature.

Unless a pay item is provided in the plans or proposal for the removal of Existing Roadway Signs, the removal, etc. of such signs will be considered incidental to the work and no measurement for pay purposes will be made. However, when the removal of existing signs is designated for pay purposes, measurement will be made on a lump sum basis for all signs designated to be removed.

710.05 Basis of Payment.

(a) Unit Price Coverage.

Sign Panels measured as noted above will be paid for at the contract unit price bid per square foot {square meter} which shall be full compensation for the sign face complete in place on its support assembly and includes all costs necessary for obtaining the material, processing, all copy, symbols, legend and the like, and for all hardware necessary to furnish and install the sign on its supports in accordance with plan details and for all equipment, tools, labor and incidentals necessary to complete the work.

Posts measured as noted above will be paid for at the contract unit price per linear foot {meter} which shall be full compensation for the particular size post involved completely installed in its proper position. Said unit price bid shall include all costs necessary to obtain materials, fabrication, processing, excavation, erecting, backfilling, backfill material, concrete, steel, clearing, all hardware, and miscellaneous parts necessary to furnish and install the post in accordance with plan details and for all equipment, tools, labor and incidentals necessary to complete the work.

Removal of existing signs under Item 710-C, measured as noted above, will be paid for at the contract lump sum price bid which shall be full compensation for the dismantling, removal of the designated sign assemblies or portion of the sign assembly, the salvaging of materials or reuse when designated, the stacking or storage of the salvaged materials in a designated location on the project, and for any materials, equipment, tools, labor and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

710-A Class _*_, _**_ Sign Panels _***_ - per square foot {square meter}
710-B Roadway Sign Post (Description & Size) - per linear foot {meter}
710-C Removal of Existing Roadway Signs - per lump sum

* Appropriate Class
** Aluminum Flat
Aluminum Multiple Flat
Aluminum Multiple Extruded
*** Approximate thickness of panel material desired.

SECTION 711
ROADWAY SIGN RELOCATION AND RENOVATION

711.01 Description.

This Section shall cover the work of removing and relocating designated existing ground mounted roadway signs. Said work requires the satisfactory removal of the existing signs, their supports and foundation and the reinstallation of the sign assembly on their supports and new foundations.

This Section shall also cover the work of renovating designated existing ground mounted roadway signs. The renovation may include, but not be limited to, cleaning the sign, replacing the sign copy, replacing sign panels and reworking the support system. The plans will show the extent of work to be performed under this item.

711.02 Materials.

Materials involved in the work under this Section will be basically the reuse of existing signs and their supports.

Any replacement or new materials required shall comply with the appropriate requirements of Article 710.02.

711.03 Construction Requirements.

(a) General.

The relocation of existing signs shall in general require the removal of a complete sign assembly (panel or panels and supports) and the re-installation of the assembly at a new designated location.

The method of removal shall be basically that of the Contractor provided such does not damage the assembly, Any damage shall require replacement of the damaged parts using materials complying with the provisions of Article 710.02 or repair of the parts as directed, without additional compensation.

Care shall be taken in removing the concrete from the support stubs so as to preclude undue damage to the stub. Any damage which will affect the reinstallation procedure shall be repaired as directed. Note is made of the fact that the shoe assemblies are matched plates and must be retained as such, otherwise the unit will not function as designed. In addition, the shoe assembly shall be reinstalled in the same manner prescribed in Subarticle 710.03(d).

Any support foundation which can not be satisfactorily removed may be left in place provided it will not be in the way of construction and it is removed to a depth of not less than 1 foot {0.5 m} below the actual ground surface and the area backfilled as directed with suitable material.

The renovation of existing roadway signs may include work to the existing sign, sign structure, or sign appurtenances. The plans will show the signs, and the work to be done to each sign, included under the renovation item.

Any dismantling of the sign assembly as well as reassembly to be done under either the relocation or renovation shall be performed in such a manner as to preclude damaging of the assembly materials.

The Sign Panels are essential for traffic control, hence, unless the road is closed to traffic, they shall not be down more than eight hours and in no case overnight. This may require the use of temporary supports during the relocation of the permanent supports. Any temporary support must be approved before use.

(b) Installation of Sign Assemblies.

The installation of the relocated supports and panels shall be as prescribed in Article 710.03 for new signs.

The existing supports may be reused provided they are not damaged during removal operations, or the Contractor may furnish new supports at his option.

After completion of the re-installation, the sign panels shall be cleaned with approved cleaning material.

711.04 Method of Measurement.

Measurement of relocated ground mounted roadway signs will be on a lump sum basis for all signs designated to be relocated.

Measurement of renovated ground mounted roadway signs will be on a lump sum basis for all signs designated on the plans to be renovated.

711.05 Basis of Payment.

(a) Unit Price Coverage.

Complete and accepted relocated ground mounted roadway sign assemblies, measured as noted above, will be paid for at the contract lump sum price bid, which shall be full compensation for the removal and relocation of the sign assembly (panel and supports) complete in place on its supports at the designated locations, for the cleaning of the panels, for furnishing all hardware or other material necessary for the re-installation of the sign assembly, for the satisfactory removal and re-installation of the supports including the excavation and backfill of the areas (old area and new area of the installation), disposal of excess materials for new foundations for supports and for all other materials, equipment, tools, labor, and incidentals necessary to complete this item of work.

Complete and accepted renovated ground mounted roadway sign assemblies, measured as noted above, will be paid for at the contract lump sum price bid which shall be full compensation for renovating the sign assembly according to plan details and for all materials, equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

711-A Roadway Sign Relocation - per lump sum
711-B Roadway Sign Renovation - per lump sum

SECTION 713
PERMANENT BARRICADE

713.01 Description.

This Section shall cover the work of furnishing and installing a complete permanent barricade system at the location shown on the plans or designated and in conformity with plan requirements and these specifications.

713.02 Materials.

Materials furnished for use shall be new, complying with the requirements specified on the plans and with the appropriate sections of Division 800, Materials, with special reference made to Sections 864, 880 and 881.

713.03 Construction Requirements.

(a) General.

All the work performed in the installation of the permanent barricade system shall be performed in a competent, workmanlike manner.

(b) Erecting Posts.

Posts shall be erected as specified in Item 630.03(a)1 unless shown otherwise on the plans.

(c) Attaching Panels and Hazard Markers.

Panels and hazard markers for the barricade shall be fastened to the rails in the manner shown on the plans. The reflectorized Type III sheeting may be affixed to the panels either before or after the panels have been fastened to the rails.

713.04 Method of Measurement.

Permanent Barricades installed as directed and accepted will be measured in linear feet {meters} to the nearest 0.1 foot {0.1 m} from end to end of each continuous installation. No separate payment will be made for any item or part of the barricade system.

713.05 Basis of Payment.

(a) Unit Price Coverage.

Accepted permanent barricade installed, measured as provided above, will be paid for at the contract bid price per linear foot {meter} for permanent barricade which shall be payment in full for the furnishing and installing of the barricade complete in place, including posts, rails, hardware, panels, reflectorized sheeting, and hazard markers and all equipment, tools, labor, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

713-A Permanent Barricades - per linear foot {meter}

SECTION 715
OVERHEAD ROADWAY SIGN STRUCTURES

715.01 Description

(a) General.

This Section shall cover the work of designing, furnishing, fabricating and erecting a complete permanent overhead sign supporting structure, less sign panels, complete in place, ready for attachment of sign panels and includes such auxiliary equipment as is specified by plan details. Such structures shall be designed in accordance with requirements noted hereinafter and plan details to the lines, grades and dimensions designated on the plans. The total length and upright height of the structures shall be verified by the contractor before submitting the designs and details.

The Contractor shall prepare and submit as soon as possible, after issuance of the notice to proceed, all required design drawings, design computations and other necessary supporting data for approval.

(b) Design, Fabrication and Installation.

The overhead roadway sign structures shall be designed, fabricated and installed in accordance with the requirements given in Section 718, STRUCTURES FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING.

715.02 Materials.

Materials shall comply in general with the requirements given in the applicable Sections of Division 800, MATERIALS and in particular to the following:

Section 880, SIGN MATERIALS.
Section 891, STRUCTURAL MATERIALS FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING.

Materials shall also comply with requirements that may be given on the Plans.

Materials and equipment installed or used without approval of the Engineer shall be at the risk of subsequent rejection. The State will not be liable for materials purchased, work performed, or any delay incurred due to failure of the Contractor to secure prior approval. Failure of the Engineer to note unsatisfactory material as received will not relieve the Contractor of responsibility. Manufacturers' guarantees or warranties on materials customarily provided shall be delivered to the Engineer upon receipt of materials.

715.03 Construction Requirements.

(a) Structures.

The overhead roadway sign structures shall be installed in accordance with the requirements given in Section 718, STRUCTURES FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING.

The special brackets, braces, etc. which support the auxiliary equipment and to which the sign panels are affixed are classified as an integral part of the structure and shall be installed as noted in this Article or detailed on the plans or approved drawings.

(b) Blank.

715.04 Method of Measurement.

Overhead Roadway Sign Structures will be measured separately by individual structures, complete in place and fully operational.

Sign panels will be measured and paid for under Section 710, with the installation, mounting, etc. performed as provided therein.

715.05 Basis of Payment.

(a) Unit Price Coverage.

Complete and accepted overhead roadway sign structures, measured as noted above, will be paid for at the contract lump sum price bid for each structure. This payment shall be full compensation for all work and materials (except sign panels) necessary for an operational sign, complete in place on its supports at the designated locations. The contract lump sum price shall also include all costs for designing the sign structure, constructing foundations and furnishing and installing all other materials for the completion of the sign.

(b) Payment will be made under Item No.:

715-A Overhead Roadway Sign Structure No. ___ - per lump sum

SECTION 717
OVERHEAD ROADWAY SIGN STRUCTURE RENOVATION AND RELOCATION

717.01 Description.

This Section shall cover the work of renovating designated existing overhead roadway sign structures. The renovation may include, but not be limited to, refurbishing the sign panels, reworking or replacing the electrical system, and reworking the support system. The plans will show the extent of work to be performed under this item.

This Section shall also cover the work of relocating, or partially relocating, designated existing overhead roadway sign structures. The relocation may include, but not be limited to, removal or

relocation of the existing signs, their supports, and foundations, and the reinstallation of the sign assemblies on their supports with new foundations as detailed on the plans. The plans will show the extent of work to be performed under this item.

If new supports or foundations are required, the Contractor shall be responsible for the same design requirements as specified in Article 715.01.

717.02 Materials.

Materials involved in the work under this Section will be basically the reuse of existing signs and their supports. No bolts, nuts, or washers which are removed shall be reused; new materials shall be equal to or better in design than the old materials.

Any replacement or new materials required shall comply with the appropriate requirements of Article 715.02.

717.03 Construction Requirements.

(a) Renovation.

The renovation of existing overhead roadway sign structures may include work to the existing sign, sign structure, or sign appurtenances. The plans will show the work to be done under the renovation item.

After completion of the renovation, the sign panels shall be cleaned with approved cleaning material.

(b) Relocation.

The relocation of existing overhead roadway sign structures shall, in general, require the removal of a complete sign assembly (panels, lights, walkway, and supports), the construction of a new foundation, and the reinstallation of the assembly at a new designated location.

The Contractor shall notify the Project Manager by letter, with a copy to the Bridge Engineer, of the date of the relocation of a sign structure. This notification shall be given no later than two weeks before the removal of the structure.

The Contractor shall arrange for the welds of relocated structures to be inspected and tested by an AWS Certified Welding Inspector in accordance with the requirements given in Section 891. The inspection and testing of the welds shall be done after the installation of the sign structure.

The method of removal shall be that of the Contractor, however, any damage to the sign structure caused by improper removal procedures shall be repaired by the Contractor without additional compensation. Damaged members or parts shall be repaired using materials complying with the provisions of Article 715.02 or as directed.

Any dismantling of the sign assembly as well as reassembly shall be performed in such a manner as to preclude damaging the assembly materials.

Structure foundations being abandoned shall be removed to a depth of not less than one foot below the existing ground surface and the area backfilled as directed with suitable material.

The installation of the relocated overhead sign structures shall be as prescribed in Article 715.03 for new structures.

After completion of the reinstallation, the sign panels shall be cleaned with approved cleaning material.

717.04 Method of Measurement.

Measurement of renovated overhead roadway sign structures will be on a lump sum basis for each individual structure renovated, complete in place and fully operational.

Measurement of relocated overhead roadway sign structures will be on a lump sum basis for each individual structure relocated, complete in place and fully operational.

Any new sign panels needed will be measured and paid for under Section 710, with the installation, mounting, etc. performed as outlined therein.

717.05 Basis of Payment.

(a) Unit Price Coverage.

Complete and accepted renovated overhead roadway sign structures, measured as noted above, will be paid for at the contract lump sum bid for each sign structure, which shall be full compensation for renovating the sign structure according to plan details and for all materials, except sign panel, equipment, tools, labor, and incidentals necessary to complete this item of work.

Complete and accepted relocated overhead roadway sign structures, measured as noted above, will be paid for at the contract lump sum price bid for each sign structure, which shall be full compensation for all work and materials, except sign panels, necessary for the removal and relocation of the sign structure (panel, lights, walkway, and supports) complete in place on its supports at the designated locations, for the cleaning of the panels, for furnishing all hardware or other material necessary for the reinstallation of the sign structure, for the satisfactory removal of the existing footings, if necessary, including the excavation and backfill of the areas (old area and new area of the installation), disposal of excess materials, for new foundations for supports, for inspection and testing of welds, and for all other materials, equipment, tools, labor, and incidentals necessary to complete this item of work.

(b) Payment will be made under Item No.:

717-A Overhead Roadway Sign Structure No. _____ Renovation - per lump sum
717-B Overhead Roadway Sign Structure No. _____ Relocation - per lump sum

SECTION 718
STRUCTURES FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING

718.01 Description.

This Section shall cover the design, fabrication, and construction of overhead roadway sign, luminaire, traffic signal, and traffic surveillance support structures.

All designs and details shall be approved before actual fabrication of a structure is started. Within 30 days after the award of the contract, the Contractor shall notify the Project Manager by letter of the names, addresses and telephone numbers of all structural fabricators along with the fabricator's proposed fabrication schedule. The notification shall be furnished for all structural fabricators that are subcontractors to a structural fabricator.

718.02 Materials.

(a) General.

Materials shall comply in general with the requirements given in the applicable Sections of Division 800, MATERIALS. Particular structural material and fabrication requirements are given in Section 891, STRUCTURAL MATERIALS FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING. Materials shall also comply with requirements that may be given on the Plans.

Concrete for foundations shall comply with the requirements of Section 501 for Class A concrete concrete.

Reinforcing steel shall meet the requirements of Section 502, Steel Reinforcement, and shall be Grade 60 {400} billet steel.

(b) Overhead Roadway Sign Structures.

Overhead sign structures shall be constructed of steel only.

(c) Traffic Signal Poles.

Unless otherwise shown on the plans, traffic signal poles shall be steel poles.

(d) Luminaire and Traffic Surveillance Poles.

Unless otherwise shown on the plans, luminaire and surveillance poles may be constructed of steel, concrete, glass fiber reinforced polymer (GFRP), or aluminum.

718.03 Design.

(a) General.

1. Design Data.

The details of pole foundations for Traffic Signals (Section 730) and Roadway Lighting (Section 750) are shown on the plans. When details of a structure or foundation are not shown on the Plans, or if the Contractor proposes alternate structure or foundation details, the Contractor shall submit complete designs and details.

Geotechnical borings may be shown on the plans. These borings may not be representative of the actual conditions encountered throughout the project. The Contractor shall be responsible for any assumptions made from these borings. The Contractor shall obtain any additional geotechnical data that is necessary for determining the actual subsurface conditions.

2. Design Requirements.

All structures shall be designed in accordance with the requirements given in the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2009 Edition*, and the requirements given in this Section. Fatigue importance factors shall be as follows:

STRUCTURE	FATIGUE IMPORTANCE FACTOR CATEGORY
Strain Poles	No Fatigue
Mast Arm Poles / Lighting Poles less than 45 ft. in height	Category II with 25 year service life
High Mast Poles / Sign Structures / Overhead Sign Bridges / Lighting Poles 45 ft. or greater in height	Category I

Wind pressures shall be calculated in accordance with "Appendix C: Alternate Method for Wind Pressures". Minimum design wind speed shall be 100 miles per hour {165 km/hr} for Mobile and Baldwin Counties and 80 miles per hour {130 km/hr} elsewhere in the State.

The Combined Stress Ratio (CSR), shall be less than or equal to 0.9, for all load cases.

3. Foundations.

Foundations shall be located to avoid damaging existing underground installations and avoid conflicting with known future installations such as pipes, conduits, guardrail posts, lighting standards, etc.

The design shall be sufficient to provide a minimum factor of safety of 2.0 against overturning and torsion induced displacement.

(b) Submittal of Designs and Details.

Details shall be submitted on six sets of prints of drawings including foundation details for sign structures when required. Each sheet shall be stamped and signed with the original signature of a Professional Engineer licensed in the State of Alabama, and not employed by the State of Alabama. The details shall include fabrication requirements such as the welding requirements for sign frames and tensioning and detensioning procedures for prestressed concrete poles.

Design computations shall be submitted in duplicate. Each set of design computations shall be prepared, stamped and signed by a Professional Engineer registered in the State of Alabama, and not employed by the State of Alabama. The design computations shall address all members, connections (welds, bolts, etc.), anchor bolts, and foundations. The designer shall note on the design computations where the design of each member meets the design requirements and deflection tolerances.

Design computations, shall include all formulas used and a copy of all calculations and/or computer printouts for each structure that cover all members, connections (welds, etc.), footings and details necessary for a complete structure design. Where computer generated designs are used, the printouts shall consist of the applied loadings, structure geometry, effective wind area and location of attachments (sign panels, signals and light fixtures), component sizes, moments, shears, reactions, component forces, component stresses, allowable component stresses, combined stress ratios, and deflections for each group loading specified in the AASHTO Sign Specifications. The method of solution used by the computer program, including all formulas used, shall be submitted.

For overhead roadway sign structures only, the Contractor shall furnish one set of reproducible drawings (mylar or equal) on standard size plan sheets (22" x 34"){559 mm x 864 mm} for record and distribution purposes, after final approval.

(c) Drilled Shaft Foundations.

Drilled shaft foundations shall be placed only in undisturbed material or in fill made by controlled compaction. Drilled shaft foundations for cantilever structures shall be designed to resist the torsional effects of the wind loads.

(d) Concrete Spread Footings.

Footings shall be placed only in undisturbed material or in fill areas constructed by controlled compaction. Footings for cantilever structures shall be designed to resist the torsional effects of the wind loads.

(e) Direct Embedment of Support.

Prestressed concrete poles shall be installed by direct embedment in the ground. GFRP poles may be installed by direct embedment in the ground. The design and details of the direct embedment shall be submitted as Working Drawings for Structures. The required embedment is the responsibility of the contractor, however the minimum depth of embedment shall not be less than L/6, where L is the above ground length of the upright member or pole.

(f) Pile Foundations.

Pile foundations may be required in areas where the upper soil layers will not support a drilled shaft or spread footing. The foundations may be designed with steel piles or prestressed concrete piles. However, steel piles shall not be used in brackish or salt water locations in Mobile or Baldwin counties, or other locations with corrosive environments. Piles shall meet the requirements of Section 505, Piling.

(g) Anchor Bolts.

Foundation anchor bolts for overhead highway sign structures and high mast lighting assemblies shall be Charpy V-Notch tested in accordance with the requirement provided in Section 891. Anchor bolts shall be a minimum one inch in diameter.

Overhead sign structures with single pole uprights shall be anchored with at least eight anchor bolts in each base plate.

Overhead sign structures with double pole (truss type) uprights shall be anchored with at least four anchor bolts in each base plate.

Traffic signal poles and luminaire poles shall be anchored with at least four anchor bolts.

High mast lighting assembly poles shall be anchored with at least eight anchor bolts.

(h) Base Plates.

All base plates shall be designed by calculating the bending moment about a line that is taken at the edge of the upright and is the shortest diagonal across the plate. The required thickness of the plate shall be based on the section modulus at the diagonal line using 60 % of the width of that line.

The allowable stresses for a base plate shall be:

- 90 % of the yield strength of the base plate for plates that are designed for the yield moment of the upright or;
- 90 % of the allowable stresses for the Group loading for plates that are designed for the actual upright service load moment.

(i) Overhead Roadway Sign Structures.

All overhead sign structures shall be supported by a reinforced concrete footing. The overhead portion of the structure shall be attached to the footing by means of base plates and anchor bolts.

The vertical dead load deflection of cantilever sign structures shall not exceed L/120, where "L" is the cantilever length in inches {millimeters}. The vertical support for a cantilever structure shall be a round uniform diameter tube which has adequate moment of inertia, without additional reinforcement, to limit the dead load deflection of the arm, including the deflection caused by bending in the vertical support, to L/120 and to a maximum angular deflection of the centerline of the upright, at the top, in relation to the centerline at its base, of 1°40'. Horizontal trusses (span type) shall be limited to a vertical dead plus ice load deflection of L/240, where "L" is the total truss length center to center of supports in inches {millimeters}. A uniform camber, in accordance with the requirements of Section 9 of the AASHTO Sign Specifications, shall be provided for all horizontal portions of a structure.

The use of full penetration circumferential welds on upright poles is not allowed.

Horizontal trusses of triangular cross-section are not allowed.

Flange plates that are used for splicing overhead truss chords and uprights shall be designed using the requirements given for BASE PLATES.

Design and basic member shape once selected shall be used throughout the project. The detail drawings shall list all ASTM or AASHTO material specifications to be used for all the structural elements.

Brackets shall be provided for the mounting of the required flat panel signs. These brackets shall permit mounting the sign faces at an angle of five (5) degrees from vertical except for louvered panels

which shall be mounted vertically. This five degree angle shall be obtained by rotating the front top edge of the sign away from the vertical position. All brackets shall be of lengths sufficient for the heights of the signs being supported.

Where required by the contract plans, tubular structures shall have electrical outlets provided on a front chord member and shall have hand holes within twelve inches of the base of vertical supports. If necessary, in order to comply with design requirements, compensation for loss in section shall be accomplished by reinforcement.

Maintenance walkways, when required by the plans, shall be provided in front of the lower front chord. No part of the walkway shall be located so as to obstruct normal viewing of the lower portion of the sign.

(j) Traffic Signal Poles.

The structural analysis of a pole shall be made at the base of the pole, and at every tenth point interval up the pole.

The maximum deflection of the centerline at the top of the pole in relation to the centerline at its base, due to the moment load of the signal and support bracket, shall not exceed two and one half percent of the pole height. Calculations shall be submitted to verify this deflection.

At intersections involving four traffic signal poles, each pole shall be designed equally for the most severe loading condition at the intersection.

The pole base design shall conform to the following table of standard parameters if the maximum bending moment in the pole is less than or equal to 300 kip-ft.

TRAFFIC SIGNAL POLE BASE STANDARD PARAMETERS					
Pole Type	Moment Range (kip-ft.)	Bolt Circle (Diameter) (inches)	Bolt Diameter (inches)	Bolt Quantity	Base Plate Thickness (inches)
P-120	Up to 120	20	2	4	2
P-170	121 – 170	20	2	6	2
P-225	171 – 225	22	2	6	2
P-300	226 – 300	26	2	8	2

If the bending moment is greater than 300 kip-ft, the bolt circle or bolt quantity, or both, shall be different from that given in the table for the standard parameters. If the proposed difference is in the diameter of the bolt circle, the diameter shall be a minimum of 27 inches.

(k) Luminaire Poles.

High mast lighting assembly poles shall be supported by a reinforced concrete footing.

A luminaire pole shall be analyzed at the base of the pole, at every tenth point interval up the pole, at section changes and at the points above and below each slip joint splice.

Design calculations shall be submitted to verify that the maximum allowable deflections will not be exceeded.

(l) Traffic Surveillance Poles.

Poles used for mounting traffic surveillance devices, or other similar devices, shall be designed in accordance with the requirements given for luminaire poles and any additional criteria (i.e., more stringent deflection, vibration damping, etc.) provided on the contract plans.

718.04 Construction.

(a) General.

The overhead roadway sign structures, luminaire supports and traffic signal supports shall be constructed in accordance with the plans, specifications, foundation design calculations and approved shop drawings. All parts of a structure unit shall be assembled on the project and the Engineer shall be provided with adequate field erection details before permission will be given to erect the structure. Once the installation of structure is started, the work shall be diligently prosecuted until its completion.

(b) Concrete Foundations.

Excavation for foundations shall conform to the neat lines shown on the plans. The Contractor shall inform the Project Manager when the excavation is complete, and no concrete shall be poured until the Project Manager has approved the excavation for each individual footing.

The foundations may be cast directly against earth or cast with forms. When forms are used they shall be true to line and grade and securely braced in place. Both forms and ground, which will be in

contact with the concrete, shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set. Tops of foundations shall be finished to the elevations shown on the plans. Ordinary surface finish shall be applied to the exposed surfaces of concrete. Exposed edges shall be chamfered.

All concrete foundations and bases shall reach a compressive strength of 2400 psi {17 MPa} before any structures are installed thereon.

All embedded items shall be installed securely and inspected by the Project Manager before concrete is poured.

(c) Direct Burial.

Excavation shall be to the depth and diameter determined from the design calculations. The pole shall be placed in position and temporarily braced, prior to backfilling. The backfill material shall be limestone screenings or washed sand. The backfill shall be saturated with water to consolidate the backfill material during placement.

(d) Anchor Bolts.

A temporary template shall be installed approximately 6 inches {155 mm} from the top and a permanent steel template shall be installed 6 inches {155 mm} from the bottom of anchor bolts so that the anchor bolts remain plumb after the placement of concrete. The template shall be fabricated with openings to facilitate the placement of concrete above and below the template. Care shall be taken to ensure that the anchor bolt threads are not damaged prior to installation of the support structure. Out-of-position anchor bolts and anchor bolts greater than 1:40 out-of-plumb are cause for rejection of the base. Bending of the anchor bolts to straighten or move into position will not be permitted.

The number and configuration of the nuts and washers required for anchor bolts shall be in accordance with the details shown on the plans.

Anchor bolts for slip bases shall have the nuts installed in accordance with the requirements given in Section 710.

Anchor bolts for non slip bases shall have their top nuts tightened by the turn of the nut method as follows:

- All leveling nuts (bottom nuts) and washers shall be brought to full bearing on the bottom of the base plate. The bottom of a leveling nut must be kept as close to the concrete base as practical, and shall not be greater than 1 inch {25 mm} away from the top of the concrete base. A leveling nut shall be adjusted on the anchor bolt so that, after the installation of all plates and nuts, there is at least a 1/4 inch {6 mm} projection of the anchor bolt above the top or lock nut (when in its final position).
- Tighten all top nuts to a "snug" condition defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.
- At this point, the nuts and washers above the base plate and below the base plate must be in full bearing on the base plate. If any gap exists between the nuts, washers and the base plate, a beveled washer shall be added to eliminate the gap. The beveled washer shall be stainless steel type 304, shall be the same diameter as the other washers, and shall be beveled as required to eliminate the gap between the nuts, washers and the base plate.
- Using an extension on the nut wrench as required, rotate all top nuts an additional one third turn. There shall be no rotation of the leveling nut during top nut tightening.
- Tightness of the nuts shall be checked in the presence of Department personnel a minimum of forty eight hours after the nuts have been rotated the additional one third turn. Any nuts found loose shall be tightened in accordance with the above procedure.
- Lock nuts shall be brought to a "snug" condition as previously described.

(e) Overhead Roadway Sign Structures

Attention is directed to the fact that the structure design as well as shop drawings for the fabrication of the structure must be approved before actual fabrication of a structure is started.

All parts of a structural unit shall be assembled on the project and the Engineer provided with adequate field erection details before permission will be given to erect the structure. The Contractor shall temporarily brace the structure as needed.

(f) Traffic Signal Poles

Strain and mast arm poles shall be installed with the proper vertical offset (or rake), as recommended by the manufacturers so as to assure a substantially vertical set when the load is applied.

Threaded adjusting nuts shall be used to establish the "rake" in accordance with the requirements for the installation of leveling nuts on anchor bolts. The use of shims or other leveling devices will not be permitted. Hardware and fittings shall be installed as shown on the contract plans and approved shop drawings.

Messenger cable supporting traffic signal heads shall not be sagged to a vertical distance greater than five percent of the length of the span between strain poles. Messenger cable supporting signal control cable only shall be sagged to a vertical distance not greater than two percent of the length of the span between strain poles. Tether cables shall not be sagged to a vertical distance greater than five percent of the length of the span between strain poles.

(g) Luminaire and Traffic Surveillance Poles

Extreme care shall be taken during installation of the luminaire assembly and surveillance devices to ensure that no damage occurs to these devices. Double nuts and washers shall be used to plumb the pole about its center axis if a twin bracket is used. When a single arm type is used, the back side of the pole shall be plumbed after the luminaire and surveillance devices and hardware have been installed, thus providing a slight rake from the traveled way.

SECTION 720
VEHICULAR IMPACT ATTENUATOR ASSEMBLY

720.01 Description.

This Section shall cover the work of furnishing and installing vehicular impact attenuator assemblies of the design shown in the detailed plans at the locations designated by the plans, the proposals or directed.

720.02 Materials.

Materials furnished for use in the manufacture of the assemblies shall comply with the requirements noted in the detailed plans. Materials used in the actual installation of the attenuation in the work shall comply with appropriate provisions of these specifications.

720.03 Construction Requirements.

Any installation which is to be performed under traffic shall be provided with adequate warning and protective devices until such time as the assembly becomes usable. Once work is begun, it shall be prosecuted diligently and continuously until the assembly is completely installed.

720.04 Method of Measurement.

Vehicular impact attenuators of the design designated by the plans or proposal will be measured in assembly installations, complete in place at the designated locations.

720.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted impact attenuator assemblies, measured as noted above, will be paid for at the contract price bid for each assembly. Said unit price bid shall be full compensation for the furnishing of all materials and the installation of the designated assembly on its foundation, in its designated location, and includes furnishing of all equipment, tools, labor and other incidentals necessary to complete the work and provide an operational assembly complete in place.

(b) Payment will be made under Item No.:

720-A Vehicular Impact Attenuator Assembly (*) - per each

* Description and Model of Attenuator Assembly

SECTION 726
PORTABLE CONCRETE SAFETY BARRIERS AND IMPACT ATTENUATORS

726.01 Description.

This Section shall cover the work of furnishing and installing a portable concrete safety barrier and impact attenuators at the locations shown on the plans, designated in the proposal or directed, along with the satisfactory removal thereof, if so directed. This Section shall also cover the work of picking up State furnished portable concrete barrier units at a designated State storage yard, their installation at the designated location shown on the plans, and the returning of the units to the State storage yard.

Portable Safety Barriers shall be classified as to "Type" which will designate the size, shape, height, etc., all in accordance with details shown in the plans. Unless specified otherwise, the type shall be optional, but once a type is selected it shall be used throughout the contract, unless otherwise approved by the Engineer. Portable Impact Attenuators shall be in accordance with details shown in the plans.

726.02 Materials.

All materials furnished for use shall conform to the appropriate requirements of Division 800, Materials, the details shown on the plans and the following:

Concrete Safety Barriers shall be manufactured by an approved producer in accordance with the requirements given in Section 831.

Concrete, unless otherwise provided by plan details, shall meet the requirements for Class A concrete given in Section 501.

Steel Reinforcement shall meet the requirements of Section 502.

726.03 Construction Requirements.

(a) General.

The Construction of barrier units shall be in accordance with the appropriate provisions of Section 501, unless otherwise noted on the plans or directed.

The finished concrete shall be within reasonably close conformity to the lines, grades and dimensions shown on the plans or directed. The barrier unit shall present a smooth uniform appearance free of objectionable cavities or projections. Where a 10 foot {3 m} straightedge is placed horizontally on the exposed faces of the unit, the surface shall not vary more than 0.02 feet {6 mm} from the edge of the straightedge.

The exposed concrete surfaces shall be finished in accordance with the requirements given in Section 501 for a Class 2 finish on exposed surfaces, unless otherwise specified by plan details.

Portable Impact Attenuators shall be constructed in accordance with plan details. The Contractor shall inspect the attenuators for damage periodically (at least weekly), and immediately after a known impact. The Contractor shall notify the Engineer of the results of the inspection in writing immediately after every inspection. Damaged attenuators shall immediately be repaired or replaced in accordance with the manufacturer's recommendations.

(b) Handling, Storage, Transporting and Installation.

The Contractor shall be responsible for the proper handling, transporting and installation of the barrier units and impact attenuators, complete in place, at the designated locations.

Unless otherwise approved by the Engineer, the units shall be lifted and supported at the points shown on the plans or directed.

Damage to any unit caused by improper handling, transporting or installation on the part of the Contractor shall be cause for the Engineer to order it to be repaired or replaced at no additional cost to the State.

726.04 Method of Measurement.

The Portable Concrete Safety Barriers of the type designated will be measured in linear feet {meters} to the nearest 0.1 feet {0.1 m} along the top surface of the barrier.

The Portable Impact Attenuators will be measured per each in accordance with the plan details for one complete attenuator and its accessories. State Furnished Portable Impact Attenuators will be measured per each.

726.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item 726-A.

The ordered and accepted Portable Concrete Safety Barrier of the designated type, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the fabrication and furnishing of the complete barrier unit and its exclusive use for the duration of the contract, all handling, hauling, installation, relocation, maintenance, removal and satisfactory disposal of the units when deemed of no further use on the project by the Engineer includes all tools, equipment, labor and incidentals necessary to complete the work.

2. Item 726-B.

The ordered and accepted Portable Concrete Safety Barrier of the designated type, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the fabrication and furnishing of the complete barrier unit and its exclusive use for the duration of the contract, all handling, hauling, installation, relocation, maintenance, and when deemed of no further use on the project by the Engineer, the removal, repair, if necessary, and delivery of the units to the Department's local storage yard and includes all materials, tools, equipment, labor and incidentals necessary to complete the work.

3. Item 726-C.

The ordered and accepted State Furnished Portable Safety Barrier units, measured as noted above, shall be paid for at the contract unit price bid which shall be full compensation for the pick-up of barrier units from Departmental storage sites, all handling, hauling, installation, relocation, maintenance, and when deemed of no further use on the project by the Engineer, the satisfactory removal and delivery of the units to the Department's local storage yard, including all materials, tools, equipment, labor and incidentals necessary to complete the work.

4. Item 726-D.

The ordered and accepted Portable Impact Attenuators of the designated design, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the fabrication and furnishing of the complete impact attenuator unit and its exclusive use for the duration of the contract, all handling, hauling, installation, relocation, maintenance, removal and satisfactory disposal of the units when deemed of no further use on the project by the Engineer and includes all tools, equipment, labor and incidentals necessary to complete the work.

5. Item 726-E.

The ordered and accepted State Furnished Portable Impact Attenuators, measured as noted above, shall be paid for at the contract unit price bid which shall be full compensation for the pick-up of Attenuator units from Departmental storage sites, all handling, hauling, installation, relocation, maintenance, and when deemed of no further use on the project by the Engineer, the satisfactory removal and delivery of the units to the Department's local storage yard, including all materials, tools, equipment, labor and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

726-A Portable Concrete Safety Barriers, Type __*__ - per linear foot {meter}
726-B Portable Concrete Safety Barriers, Type __*__ - per linear foot {meter}
726-C State Furnished Portable Concrete Safety Barriers - per linear foot {meter}
726-D Portable Impact Attenuator (__**__) - per each
726-E State Furnished Portable Impact Attenuator - per each

* Show specific type, if required.
** Description and model of attenuator assembly

SECTION 728
TRUCK MOUNTED IMPACT ATTENUATOR

728.01 Description.

This Section shall cover the work of furnishing Truck Mounted Impact Attenuator Units and all services and operational supplies necessary to provide a functional unit during the life of the contract. Impact attenuator units that attach by a trailer will also be considered as truck mounted.

The Contractor shall retain ownership of the truck and impact attenuator unit, including all hardware and attachments, after their use on the project is complete.

728.02 Materials.

All truck mounted impact attenuator units furnished for use under this Section shall be new or acceptable used units which include all of the latest modifications to manufacturer's current production models.

The Contractor shall furnish the Engineer a copy of the certification by the testing agency that the attenuator meets the performance standards given in NCHRP Report 350, TL-2 for a work zone speed limit of 45 miles per hour and TL-3 for a work zone speed limit of 50 mph or greater. Truck mounted attenuators shall be used in accordance with the manufacturer's recommendations including the support truck weight and roll ahead distance.

The impact attenuator shall have a standard trailer lighting system, including brake lights, tail lights, and turn signals.

728.03 Construction Requirements.

(a) General.

The truck mounted attenuator unit furnished under this Section shall be used when work is performed under traffic.

(b) Maintenance.

All truck mounted impact attenuator units shall be maintained in such a manner as to provide continuous service during their use on the project. Units which become non-operational during use will require the Contractor to suspend work until the units can be repaired or replaced.

The truck mounted impact attenuator units shall be stored in an approved secure storage area when not in use.

728.04 Method of Measurement.

Measurement of Truck Mounted Impact Attenuator Units will be made in complete functional units.

728.05 Basis of Payment.

(a) Unit Price Coverage.

The ordered and accepted truck mounted impact attenuator units under this item, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the furnishing of the unit, complete with truck, and its exclusive use on the project, for providing all equipment, supplies, services, labor and incidentals necessary to operate and to maintain the units in good serviceable condition during the life of the contract.

(b) Payment will be made under Item No.:

728-A Truck Mounted Impact Attenuator Unit - per each

SECTION 729
INTELLIGENT TRANSPORTATION SYSTEMS

729.01 Description.

This Section shall cover the work of furnishing, installing and testing Intelligent Transportation Systems (ITS).

Descriptions and definitions of the equipment, words and terminology used in the furnishing and installing of Intelligent Transportation Systems (ITS) equipment are given in the Manual of Uniform Traffic Control Devices (MUTCD) and the publications of the Institute of Transportation Engineers (ITE), the National Electrical Manufactures Association (NEMA), the National Fire Protection Association (NFPA), and the International Municipal Signal Association (IMSA).

729.02 Materials.

All materials furnished for use shall conform to the requirements given in **Section 893** and the requirements shown on the Plans, and/or listed on the Alabama Department of Transportation (ALDOT) "*Materials, Sources, and Devices with Special Acceptance Requirements Manual*" (MSDSAR). All

furnished materials and equipment shall be new and free from defects. Existing equipment shall only be used if shown on the Plans to be re-used.

729.03 Construction Requirements.

(a) General.

ITS devices/equipment (i.e., cabinets, cameras, Dynamic Message Signs, Vehicle Detection Systems, etc.) shall NOT be mounted on structural members until erection or final placement of the structure (i.e., Overhead Sign Bridge, ITS Pole, etc.).

1. Drawings and Specifications.

Installations shall comply with the regulations of the latest edition of the National Electrical Code (NEC) (a.k.a. NFPA 70), the latest edition of the National Electrical Safety Code (NESC) (a.k.a. ANSI/IEEE C2), and local Utility regulations.

2. Material and Equipment Lists, Shop Drawing Approval.

Material and equipment listings shall be submitted to the Design Bureau's Traffic Engineering Division for approval within thirty (30) calendar days after the issuance of the "*Notice to Proceed*". Material and equipment lists shall include catalog cutouts or published data sheets and shall be completed on the Department's Material Submittal Form D-40. Material Submittal package(s) and Form D-40 shall be electronically completed and submitted in accordance with Traffic Engineering Division's procedures as outlined in the Form D-40 quick help guide and instruction documents. All components required for a complete system, sub-system and/or pay item shall be listed on the Form D-40 as defined in the form's instruction documents. Partial listings or incomplete shop drawings for any individual pay item, system, or sub-system will not be accepted for consideration and shall be returned for correction without review.

Any changes to the approved material and equipment lists must be requested in writing through proper channels.

If requested by the Engineer, the Contractor shall submit for inspection and approval samples of both the specified and proposed substitute items at no cost to the Department. The Department will not be liable for any equipment purchased or work done, or any delay incurred before such approval. Failure of the Engineer to note unsatisfactory equipment as received will not relieve the Contractor from responsibility.

Manufacturers' warranties and guaranties furnished on equipment used in the work shall be delivered to the Engineer; likewise, instruction sheets and parts lists shall be delivered to the Engineer upon receipt of the equipment.

Throughout the entire project, the same manufacturer shall make all units of any one item.

3. Supporting Structures and ITS Poles.

Supporting Structures and ITS Poles used for mounting the equipment shall conform to the requirements given in **Section 718** and **Section 891**.

Concrete ITS Pole with metal tenon extension shall be installed per the manufacturer's recommendations and as shown on the Plans.

4. As-Built Drawings.

The Contractor shall submit as-built documentation of work provided in accordance with this Specification upon completion of the Burn-In Period as required in **Sub-Article 729.03(s), "*Burn-In*"**. As-built submittal packages are to be neat, legible, and orderly. All electronic/digital copies shall be submitted via Department approved media. Except for standard bound materials, bind all letter-size (8.5 inch x 11 inch) documentation, including ledger-size (11 inch x 17 inch) drawings folded to letter-size (8.5 inch x 11 inch), in logical groupings in loose-leaf binders of 3-ring, plastic comb, or plastic coil/spiral type. All binders and media shall have typed labels affixed identifying its contents.

The following documents, at a minimum and as they are applicable, shall be included: [Contractor shall furnish at least two (2) sets of bound documentation.]

a. User/Operation Manual.

The Contractor shall furnish a manual containing detailed operating instructions for each different type or model of equipment.

The Contractor shall deliver two (2) hard copies and one (1) electronic searchable copy of each User/Operation Manual to the Engineer upon completion of the Project. The User/Operation Manuals shall be for the ITS electronic equipment and any software provided on the Project. The

User/Operation Manuals should be grouped into the following ITS component areas: camera, VDS, network devices and other equipment.

b. Maintenance Procedures Manuals.

The Contractor shall furnish a manufacturer's manual containing detailed preventative and corrective maintenance procedures for each different type or model of equipment.

c. System Connection Diagrams.

The Contractor shall furnish diagrams showing the ITS site detailing the wiring between devices.

d. Drawings.

The Contractor shall furnish a corrected set of plans showing in detail all changes made during construction from the original plans. These corrected drawings shall also include: (a) schematic wiring/circuit diagrams; (b) cabinet wiring diagrams; (c) actual route location and depth of conduits, encasements and CommBoxes; and, (d) aerial cable route locations including poles and pole attachment heights (at a minimum). Cable and conduit route locations shall be collected in Department approved GPS format with a horizontal tolerance of ±6 inches {15 cm} and a vertical tolerance of ±12 inches {30 cm}. These readings for cable and conduit are to be taken every 50 feet {15 m} and at changes in direction unless otherwise directed by the Engineer. GPS readings shall also be taken at the top center of installed CommBoxes. Resulting field survey data shall be provided in an ESRI ArcGIS shapefile format and include any necessary descriptive fields. These corrected drawings and field survey shall be furnished as an electronic copy.

These corrected drawings should not be finalized for submittal until after all equipment and materials have been installed at their final location and a successful Acceptance Test has been completed.

Along with these corrected drawings, all testing documentation and test results as required within the Specification shall be included in the as-built submittal package.

e. ALDOT OSP Database Forms.

The Contractor shall provide the Department with completed Outside Plant (OSP) Database Forms which document fiber optic cable and ITS device installation information. These ALDOT forms should be supplied in PDF file format to the Contractor by the Engineer at the Pre-Construction meeting. These forms are to be printed and hand-completed by the appropriate technician (i.e. Fiber Optic Technician for fiber optic cables; and ITS Technician for ITS device/equipment) in the field at each site as corresponding form installation occurs, unless otherwise directed by the Engineer. The Engineer shall field verify submitted forms for accuracy; and then transmit acceptable forms to the Area Traffic Management Center Supervisor for OSP database entry. Copies of these forms should also be sent to Design Bureau's Traffic Design ITS Group for their records. If any data is missing or any questions regarding form entries are noted at data entry, the forms in question will be returned to the Contractor for corrective action. The Contractor must complete these forms and submit them in a timely manner for review and entry. Otherwise, the Acceptance Test and Burn-In will be subject to being held up.

5. Approved Intelligent Transportation System Devices and Materials.

Some materials and equipment required to be furnished under this Section will be standard production type products. Acceptance will be made by the Engineer based on selected confirmation tests, the manufacturer's certification of the materials and equipment, and visual inspection at the job site. Approved devices are shown on the Department's **List VI *"Approved Intelligent Transportation System Devices and Materials"***. Information concerning this list is given in **Sub-Article 106.01(f), "*Use of Materials with Special Acceptance Requirements*"** and **ALDOT-355, "*General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements*"**.

6. Coordination of Work.

Coordination with roadway work and with bridgework shall be of prime importance to prevent undue damage to completed items of work and to existing facilities. Any damage to existing facilities caused by the installation of the material or equipment required under this Specification shall be repaired by the Contractor at no additional cost to the Department.

The Contractor shall field verify equipment locations with the Engineer prior to installation.

7. Restoration of Site.

During the installation of the underground systems, removal of brush, trees, fencing, and other obstructions within the right-of-way shall comply with **Section 201** and shall be paid for separately under that Section. Landscaping shall be restored to original or better condition if disturbed.

8. Excavating and Backfilling.

Excavation required for the installation and placement of conduits, foundations, CommBoxes, ITS poles and other appliance shall be performed in such manner as to cause the least possible injury to pavement, curbs or other improvements.

Trenches shall not be excavated wider than necessary for the proper installation of the required conduits, wires and/or fiber optic cables. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur. Any trenches required for construction shall be backfilled the same day. Surplus excavated material shall be removed from the site the same day and disposed of by the Contractor, or as directed by the Engineer.

Compaction shall be accomplished to the extent necessary to prevent future settlement of the backfill.

The Contractor shall be required to restore any areas disturbed by his work to their original condition without additional cost to the Department.

9. License and Certifications.

The Contractor responsible for the performance of the work shall be licensed as a General Contractor authorized to perform electrical work by the Alabama State Licensing Board for General Contractors and in good standing.

At least one out of every three persons in each work crew shall be a Journeyman licensed by the Alabama Electrical Contractors Board and in good standing. Journeymen shall be present and shall have direct involvement with all work required for the installation and operational testing of electrical materials and equipment.

The Contractor shall submit copies of the General Contractor license, Journeyman licenses and certifications to the Engineer as a part of the submittal of the list of materials proposed for installation. Work shall not begin on the installation of electrical materials or equipment until copies of the licenses and certifications have been approved by the Engineer.

Fiber Optic related work shall be completed by qualified Fiber Optic Technicians as defined in **Item 729.03(b)1** ***"Fiber Optic Technician Qualifications"***.

(b) Fiber Optic Cable.

The Contractor shall assemble and install all necessary material and equipment and furnish a working fiber optic cable as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

All optical fibers within each and every cable shall be usable and shall be 100% attenuation-tested by the manufacturer. The minimum information required within these attenuation testing results are defined in the materials section of this Specification (see **Item 893.02(a)6, *"Quality Assurance and Packing"*** for details on the "*cable reel data sheet*"). The cable reel data sheet shall be provided with each reel and affixed within the reel wrapping. When the cable reel is received from the manufacturer, a copy of the cable reel data sheet (a.k.a. "*manufacturer's certified test report*") along with any other shipping documentation shall be submitted to the Engineer. The cable reel tag is to be delivered to the Engineer upon its removal during cable installation. Once the documentation is no longer needed for their use, the Engineer should forward these items (or a copy) to the ALDOT Region TSM&O Engineer for their permanent records and for fiber optic database storage.

The Contractor shall insure fiber optic cable is stored in temperatures that meet the manufacturer's recommendations.

1. Fiber Optic Technician Qualifications.

The Fiber Optic Technician qualifications shall be submitted with the Material Submittal package for approval. The Contractor shall have the Engineer's approval of the Fiber Optic Technician's qualifications prior to commencing work. These technicians shall be in possession of their certification at all times and show this certification as often as asked by the Engineer. The Department reserves the right to revoke the approval of any technician not demonstrating the skill and knowledge to perform at accepted industry standards. Failure to provide proof to the Engineer will result in a stop work being placed upon fiber optic work until such a time that proof of meeting

these Fiber Optic Technician Qualification requirements are met. Contract time will not be stopped if the Contractor is unable to provide adequate proof or qualified staff.

Only technicians that meet all these requirements shall perform fiber work including splicing, terminating fiber, and testing of fiber.

Technician performing fiber terminations, splicing, and testing shall have:

a. Education:

Attended and successfully completed at least one four (4) day class on installation of fiber optic products conducted by major manufacturer of fiber products or an accredited/approved firm or organization. The entity conducting the training, along with the class and materials, shall be current and accredited for certification by one of the following United States based certification organizations: Electronics Technicians Association (ETA), The Fiber Optic Association (FOA), or International Municipal Signal Association (IMSA). Fiber Optic Technicians shall maintain their certification and be in good standing with the applicable certification organization while performing such work on ALDOT projects. Technicians with expired or suspended certification shall not be allowed to conduct work.

b. Work History:

Technicians shall have a minimum of two (2) years of work experience with one year continuous for splicing, terminating and testing fiber optic cable. Work experience shall be within the last 5 years. The applicant shall submit a resume providing a summary of qualifications and a general description of professional experience, education and training in the fiber optic installation techniques (termination, splicing and testing). The applicant shall also provide a work record for the previous two years detailing specific project, types of installations, testing and a customer reference for each project. The applicant should include as much additional detail as reasonable to facilitate approval.

2. Fiber Optics Material Installation.

It shall be the Contractor's responsibility to protect reeled fiber optic cable from vandals or other sources of possible damage while unattended. The sections of cable intended for duct installation are produced to meet specific length requirements. Any damage to the cable sections may require replacement of the entire section, at the discretion of the Engineer.

The Contractor shall be responsible for damage to the cable during handling and placing, and responsible for all cost to replace damaged fiber optic cable. The cable manufacturer's specifications regarding tensile strength, pulling capacity, and bending radius, etc. shall not be violated.

Whenever unreeled cable is placed on the pavement or surface above a manhole, the Contractor shall provide barricades or other means of preventing vehicular or pedestrian traffic through the area.

The "*figure-eight*" configuration shall be used when installing fiber optic cables. Fiber optic cable should not be coiled in a continuous direction except for lengths of 100 feet {30.5 m} or less. The preferred size for the "*figure-eight*" is about 25 feet {7.6 m} in length, with each loop 9 feet {2.7 m} to 14 feet {4.3 m} in diameter. Traffic cones spaced 10 feet {3.0 m} apart are useful guides during "*figure-eighting*". When "*figure-eighting*" long lengths of cable, care should be taken to relieve pressure on the cable at the crossover of the eight.

On projects where a fiber optic cable is to be mechanically or hand pulled, a "*Pull Tape*" as specified in **Sub-Article 893.10(d)** shall be factory or field installed within conduit for the purpose of attaching to, and the pulling of said cable. PULL ROPES NOT SPECIFICALLY DESIGNED FOR FIBER OPTIC AND ELECTRICAL CABLE INSTALLATION SHALL NOT BE USED ON ANY ALDOT PROJECT.

If a mechanical pulling machine is used, it shall be equipped with a monitored or recording tension meter. At no time shall the cable manufacturer's recommended maximum pulling tension be exceeded. The fiber optic cable's central strength member and aramid yard shall be attached directly to the pulling eye/pulling grip in accordance with the cable manufacturer's Standard Operation and Installation Procedures (SOP). Contractor shall use cable manufacturer approved pulling grips to ensure that the cable's optical and mechanical characteristics are not degraded during installation.

a. Installation and Standard Operation Plan.

i. Manufacturer's Operation and Installation Procedures.

The Contractor shall install in accordance with the cable manufacturer's Standard Operation and Installation Procedures (SOP). These procedures shall be provided upon the request of the Engineer.

ii. Contractor's Installation Plan.

The Contractor shall submit to the Engineer for approval a detailed installation plan for all fiber optic cable installed as part of this project. The Contractor shall have the Engineer's written approval prior to commencing any fiber optic cable installation.

This installation plan shall include all proposed end-to-end cable splice points which shall be in a CommBox that was already designated as a splice point. The Contractor will be required to limit the amount of splice points within the network and maximize the length of each cable run. Reel lengths and end-to-end cable splice points shall be submitted by the Contractor and approved by the Engineer prior to the ordering of the fiber optic cable.

b. Designated Cable Slack (Maintenance Coil).

Throughout the fiber optic cable installation, the Contractor shall be required to pull and store excess cable slack at designated intervals. The following lengths of slack cable shall be minimums used unless otherwise shown on the Plans:

CommBox with Splice Closure	75 ft. {23 m} per cable end
CommBox without Splice Closure	150 ft. {46 m} per cable
Pull Box	100 ft. {30 m}
ITS Cabinet/Controller Cabinet	10 ft. {3 m}
Hub Building	100 ft. {30 m}
TMC/Transportation Control Center (TCC) (OSP Entrance)	100 ft. {30 m}

c. Slack Storage.

The Contractor shall not leave slack cable lying free on the ground, bottom of a CommBox, bottom of a pull box, or floor of a Hub/TMC/TCC. Only during the actual pulling process will this be allowed. If channeling rack is not available on existing, the Contractor may leave slack upon approval of the Engineer.

d. Aerial Lashing.

Aerial cable shall be lashed to a separate stranded steel messenger wire within a Medium Density Polyethylene (MDPE) jacket. The fiber optic trunk cable shall not be lashed to messenger wire also used for signal heads or other similar items.

e. Riser Duct.

Riser duct shall be in accordance with RISER ASSEMBLY requirements within this Specification and as shown on the Plans.

3. Fiber Optic Cable Tag and Labeling.

a. General.

The Contractor shall label all fiber optic cabling with a unique identification in a permanent and consistent manner that is approved by the Engineer prior to installing fiber cable. The Engineer shall provide the Contractor with the identifications to be used. Fiber optic cable tag labels shall meet the material requirements within this Specification and as shown on the Plans. The Contractor shall provide these unique cable tag identifications on all test results or fiber related documents provided to the Engineer.

Metal or non-metal fiber optic cable tags are to be primarily used within CommBoxes, ITS Cabinets, and Hub Buildings. Special non-metal aerial fiber optic cable tag labels are to be used for aerial installations. Cable tag labels shall be affixed to the cable per the manufacturer's recommendations; and shall be affixed in a manner which will not cause damage to the fiber. Handwritten labels shall not be allowed.

The Contractor shall install cable tags within 1 foot {0.3 m} of each splice and/or termination point. Each tag label shall identify the cable type, fiber count, and each fiber optic cable origination and termination points (or next ITS site that the cable is connecting).

b. Aerial Fiber Cable Labeling.

Aerial fiber optic cable tags shall meet the material requirements within this Specification and as shown on the Plans.

Aerially-mounted fiber optic cable tags shall be placed at 500 ft. {152 m} increments linearly along the fiber optic cable path and shall be identifiable as ALDOT fiber when viewed from ground level.

A "*proof check*" sample, of quantity one, shall be produced and provided to the Engineer prior to procurement of the remaining units. The Contractor is required to obtain the Engineer's approval of the "*proof check*" sample prior to subsequent procurements by the Contractor. If the Contractor does not obtain approval prior to subsequent procurements, the Contractor assumes the risk of the aerial fiber optic cable tags being rejected even after installation. No payment shall be made to the Contractor if the aerial fiber optic tag is rejected.

4. Fiber Optic Testing.

The Contractor shall supply all equipment, materials and software necessary to perform the test as specified within the Specifications. Fiber optic testing shall be performed by certified Fiber Optic Technicians approved as specified within the Specifications.

Test for attenuation, decibel loss, shall be measured in dB/km. The Contractor required fiber tests shall be done by a certified Fiber Optic Technician in the presence of the Engineer or his/her designee.

a. Fiber Optic Test Methods.

i. Power/Light Meter Test.

A typical Power/Light Meter Test consists of the following steps/conditions:

- Connect the light source to the terminated fiber at the location identified by the Engineer. Connect a power meter to the other end of the fiber at the location identified by the Engineer. Record the results in accordance with standard industry practice and submit the test report to the Engineer.
- Use the light frequencies of 1310 nm and 1550 nm for single-mode unless otherwise directed by the Engineer.
- Perform the test bi-directionally.

A Project Inspector shall witness and approve the results before final acceptance by the Engineer.

ii. Optical Time Domain Reflectometer (OTDR) Test.

OTDR shall be used for fiber testing as a means of determining the integrity of the fiber strands. A launch cable of a length exceeding the "dead zone" of the OTDR or a factory "*fiber box*" of 246 feet {75 m} minimum with no splices within the box shall be used for testing with the OTDR. If a patch cable is utilized, the length of patch cable shall be stored on a fiber storage bobbin with a 5 inch {127 mm} minimum diameter. Termination of the fiber for testing shall be the factory fiber via "*lab splice*", mechanical splice, or fusion splice, bare fiber adapter, or mechanical termination. Supplemental patch cables and barrel connectors to transition between connector types shall not be allowed. The traces shall demonstrate dB/km loss not to exceed +3% of the factory test documentation that came with that reel of fiber or 1% of the cable's published production dB loss per km as specified within the Specifications plus the maximum OTDR error level as noted by the manufacturer of the OTDR (typically +2%). The OTDR should be calibrated to show anomalies of 0.1 dB minimum. When a "*gainer*" appears in an OTDR trace, that strand shall be bi-directionally tested. Each trace shall include the following data:

- The trace itself with a launch transition not to exceed 6 dB;
- *Measurement results* - cursor, marker, distance between cursor and marker, total loss between launch point and end of fiber, attenuation calculation in dB/km;
- *Cable information* - fiber identification (if not the filename), cable identification (reel number and manufacturer's identification reel number), OTDR location, end of fiber location, operator identification, date shot, time shot; and,
- *Set up parameters* - wavelength, pulse width, refractory index, range, and horizontal scale.

b. Fiber Optic Test Times (Milestones).

The following fiber optic testing times/milestones should be observed and/or documented to the satisfaction of the Engineer.

i. Manufacturer's On-Site Testing.

The cable manufacturer shall provide necessary documents to validate test equipment along with test results delivered and provide to the Engineer upon cable delivery.

ii. General Receiving Test.

The Contractor shall provide the ALDOT Region TSM&O Engineer the fiber cable manufacturer's OTDR test results and Power/Light Meter readings for each strand of outdoor fiber (i.e., trunk, drop, aerial, and armored) prior to performing the fiber optic cable receiving test.

Prior to any work, the Contractor shall certify to the Engineer that any and all fiber optic cable that is to be used on said project has been delivered to the work site and/or the Contractor's storage facility and meets the requirements as specified within the Specifications and was undamaged during shipping. Compliance with this requirement shall be accomplished in the following manner.

The Contractor is recommended to OTDR test each fiber strand per loose tube on each reel of cable 14 days prior to installation.

The Contractor and Engineer shall jointly inspect and test all reels of cable for damage prior to installation. The fiber optic cable shall meet the following factory attenuation criteria:

- Fiber cable attenuation specified herein for 1310 nm and 1550 nm,
- Strand lengths are consistent in the OTDR reports,
- Launch Transition < 0.6 dB, and
- No event shown in the OTDR trace > 0.10 dB.

Upon completion of these test procedures, the Contractor shall issue to the Engineer all test data as specified and a "*Letter of Quality Assurance*" from said Contractor stating that the fiber cable has been delivered to the construction site and/or the Contractor's storage facility and meets the requirements as specified within the Specifications.

Upon the Engineer's acknowledgment of the receipt and acceptance of the Letter of Quality Assurance, the Contractor may commence installation of said cable at the Contractor's risk. No fiber optic cable shall be installed prior to the receiving test and the acceptance of the Engineer.

iii. Existing Fiber Testing.

The Contractor shall test any existing fiber cable to be used on the project before beginning any fiber work on those fibers. Existing dark fibers, whether to be used on the project or remain dark, shall be OTDR tested. Testing of any existing fiber strands that are currently lit shall be coordinated with the Engineer for scheduling when the lit fiber may be taken offline for testing. A minimum of seven (7) calendar day notice shall be given to the Engineer before testing lit existing fibers. These fiber test reports shall be submitted to the Engineer for review and acceptance.

iv. Installation and Post Fiber Testing.

As the cable is pulled off the reel, it shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately. The Contractor shall submit to the Engineer the proposed corrective action to be taken for review and acceptance.

Armored fiber optic cable shall be properly grounded upon cable installation. This grounding system shall be tested in accordance with the Specifications.

Post installation testing ensures the integrity of the fiber strands have not been damaged during the installation process. Once the fiber cable has been installed, the Contractor shall OTDR test each fiber strand before proceeding to splicing and/or terminations. These OTDR test results shall be compared to the receiving OTDR test results for determining if any fibers were damaged by the Contractor's work during construction. In such case that there is damage done during construction the Contractor shall be responsible for all equipment, materials and labor to repair the damage to the satisfaction of the Engineer at no additional cost to the Department. The Engineer has the final determination of what constitutes damage during construction. At minimum, no event shall exceed 0.10 dB post installation. The process for repair and/or replacement of cable shall be submitted to the Engineer for review and acceptance prior to conducting the work. Repaired and/or replaced cable shall be retested to ensure compliance with standards. Test reports shall be submitted to the Engineer for review and acceptance.

v. Termination/Splicing Complete Testing.

Upon completion of the installation of fiber cables, drop cables, splices, and termination of cable ends; dependent on the project requirements as shown on the Plans, each fiber terminated and spliced shall be OTDR and Power/Light Meter tested.

The Contractor shall review the OTDR and Power/Light Meter results to ensure the fiber attenuation, splice loss, and connector pairs meet the requirements as specified within the Specifications. The reviewer (also a certified Fiber Optic Technician) shall be different from the certified Fiber Optic Technician who performed the installation and tests. The Contractor shall

clean, polish, re-terminate, and/or re-splice in order to bring the results within specified tolerances.

vi. Fiber Optic Test Reporting.

Upon completion the Contractor shall issue to the Engineer all traces and loss/length print outs. These are to be submitted in a suitable binder organized by cable and strand number. A cover sheet is required for each binder indicating which cable(s) were tested, the OTDR user's name, the certified reviewer's name, the type of test performed, and the date(s) of the test. Cover sheets for final test results bearing the reviewer's signature, the date signed, and a statement indicating that the installation complies with the Specification's requirements are required. The Contractor's employee who has reviewed the traces is required to sign or initial them. A check mark is required on all traces that satisfy the Specification's requirements. For intermediate test results, the Contractor shall flag any discrepancies that may exist with a short description of the proposed corrective action (e.g. re-splice). Where test results do not satisfy the requirements as specified within the Specifications, the Contractor shall provide justification as to why the testing and/or material are not able to prove meeting the requirements as specified within the Specifications. This binder/package is to be submitted to the Engineer for fiber work acceptance and distribution. Also with this binder/package, the Contractor shall submit to the Engineer on a data compact disk or other approved electronic media the raw OTDR fiber trace files along with the OTDR documentation (manufacturer/model/serial number). The Contractor may alternately submit this binder/package as an electronic submittal (preferably in PDF format or as approved by the Engineer).

No payment for splices or terminations shall be made unless fiber optic test reports and ALDOT's OSP Database Forms have been accurately completed by the Contractor and submitted to the Engineer.

(c) Fiber Distribution Units (FDU), Connectors, and Fan-Out Kit.

The Contractor shall assemble and install all necessary material and equipment and furnish a working Fiber Distribution Unit as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

1. Distribution Hardware.

The following distribution equipment specifications cover installations of Fiber Distribution Units from the headend and hub, primary fiber distribution unit (PFDU) to secondary fiber distribution unit (SFDU) which are utilized within the individual cabinets and communication closets within buildings or within hub buildings.

When splicing in the field within a CommBox or aerial installation, a splice closure shall be provided as indicated on the Plans and in accordance with **Article 729.03(q)2, "*Installation of Splice Closure (Underground and Aerial)*"**.

2. Fan-Out Kit.

Fan-out kits shall be installed per fan-out kit and/or fiber optic cable manufacturer procedures and standard fiber connector installation training. Fan-out kit shall be compatible with the fiber optic cable being terminated and shall be color-coded to match the optical fiber scheme or as specified within this Specification.

3. Fiber Connectors.

Installer of fiber connectors shall have been trained to perform the installation of the type of connector being installed. Manufacturer guidelines shall be followed. Prior to testing connector, installer shall visually verify connector end is clean of foreign materials using a fiber scope. Heat cure epoxy connectors are the preferred method and shall be used unless otherwise indicated on the Plans.

4. Cable Management.

The Contractor shall ensure that fiber cables are installed in the manner in which they were designed for the FDU. Cables shall be secured in the locations designed by the FDU manufacturer using zip ties while ensuring the fiber cable is not overly bound causing attenuation loss in the fiber cable. The excess end of zip ties shall be cleanly cut flush. Fiber cable shall not be stretched, kinked, or bound when run within the cable management system.

5. Splice and Termination Procedure.

The procedure for fusion splicing shall be submitted to the Engineer for approval. This submittal shall consist of:

a. OSP Database Form(s);
b. manufacturer/model of fusion splicer and date of last calibration;
c. form of splice protection; and
d. means of accessibility for splice protection and traffic control.

The Contractor shall only splice fibers at locations as shown on the Plans unless otherwise approved by the Engineer.

All splices shall be protected and stored in fiber optic splice units or integrated fiber optic splice and termination units that are housed in field cabinets, pull boxes, CommBoxes, hubs, and other buildings.

The Contractor shall document all splice and terminations on forms provided by the Engineer. No payment for splices or terminations shall be made unless forms have been accurately completed by the Contractor and accepted by the Engineer.

Fiber optic cables shall terminate in a fiber optic splice closure or fiber distribution unit where ends are protected. During installation, fiber optic cable ends must be protected per manufacturer recommended methods and as approved by the Engineer.

6. Pre-terminated Connector Assemblies.

Pre-terminated Connector Assemblies (i.e., Factory Connector Build-Outs, or pigtails) may be spliced onto a cable as an alternative to installing heat cure epoxy or mechanical connectors. Pre-terminated Connector Assemblies shall be installed per manufacturer's standard operating procedures of the fiber optic cable and fiber distribution unit; and, as approved by the Engineer.

Pre-terminated Connector Assemblies (PTCA) cables shall be labeled where the buffer tube being spliced is permanently indicated on the PTCA cable jacket. This labeling is to be done prior to splicing.

7. Fiber Optic Patch Cable.

Fiber optic patch cables (a.k.a. patchcords or jumpers) shall be appropriately sized for the length of run. Excess patch cable is to be limited to no more than one slack coil of 6 inch diameter. Fiber optic patch cables and connectors shall be compatible with the fiber optic cable and equipment to which it will connect.

(d) Network Devices.

The Contractor shall assemble and install all necessary material and equipment and furnish a working Network Device as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape. Final network device locations shall be accepted by the Engineer prior to installation.

1. Managed Ethernet Switch.

a. Installation.

Managed Ethernet Switch (MES) shall be installed as shown on the Plans and mounted using manufacturer recommended parts. Ensure that the switch is resistant to all Electromagnetic Interference (EMI). Verify that the switch is mounted securely and is fully accessible by field technicians. Wiring shall be run within wire raceways and secured using zip ties.

2. Wireless Network Device.

a. Wireless Equipment Selection and Installation.

The Contractor shall be responsible for determining field conditions of licensed and unlicensed wireless radio site including interference (noise). The Contractor shall perform wireless path loss analysis to determine appropriate radio equipment and antennas and mounting heights necessary for each site. This analysis shall be provided to the Engineer for review and acceptance. The Contractor shall be responsible for selecting equipment which meets the minimum performance requirements shown within the Specifications with the required annual availability at the most constrained modulation (i.e., smallest dB range in modulation to obtain for that radio unit).

Prior to deploying and operating a licensed frequency, the Contractor is responsible for performing a frequency coordination, filing a public notice, and submitting an application (Form 601) with the FCC to ensure that no one else is already operating on the same frequency or a frequency that will inject interference on existing systems. If licensed radios encounter interference, it is typically resolved with the assistance of the regulatory body.

b. Antenna Installation.

Technicians performing installation work shall have a hardware certification by the microwave manufacturer on the product being installed.

Prior approval from the Engineer shall be obtained for the installation and sealing process when field drilling is required to mount an antenna on an existing cabinet and/or support structure.

Antenna mounts shall be secured to prevent movement of antennas in high wind conditions. Once the antennas are aligned, the position shall be marked with torque marking paint that shows any movement about the azimuth and elevation axis. Pictures of these marks shall be submitted as part of the as-built plan set submittal. These marks shall be made such that they do not deteriorate in the weather or sun.

c. Cable Installation.

Cable shall be routed as shown on the Plans. When the Plans do not denote a specified route, prior approval from the Engineer shall be obtained for the proposed route. Cables mounted internal to structure supports shall use a hoisting grip to properly secure each cable type at the top of the support structure. Lightning arrestors shall be installed as shown on the Plans and grounded on the support structure. Wiring connections in supports shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape. A drip loop shall be provided where cable enters a support structure; the bottom of the loop shall be lower than the cable entry point. Structure entries shall be through a weatherhead, grommet or sealed using butyl rubber.

(e) Camera.

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working Closed-Circuit Television (CCTV) camera as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied and installed by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

The Contractor shall provide a camera installation complete with associated detection equipment, control equipment, power supplies, and any other camera-related field electronic equipment and transient voltage surge suppression as shown on the Plans and as specified within the Specifications. The Contractor shall provide an installation kit with mounting brackets, data cables, power cables, hardware and any incidentals required by the manufacturer.

The Contractor shall maintain full responsibility for the camera housing mounting to the support structure and confirm that the camera can be properly mounted on the support structure prior to installation. The Contractor shall securely mount the camera on the support structure. The camera shall be constructed and shall be adjusted to obtain optimum function of the camera.

The camera, cabinet, and other components shall be mounted at locations as shown on the Plans. The Contractor is responsible to ensure that the camera does not interfere with the operation of any other ITS electronic equipment when installed.

The Contractor shall be responsible for camera configuration and initial settings (i.e., date/time stamp, compass orientation, time server IP address, alert settings, camera ID label, SNMP settings, and initial user account login defaults). These camera settings shall be coordinated with the ALDOT Region TSM&O Engineer prior to placing camera and associated equipment in service.

a. Cabinet Equipment.

i. Controller Cabinet Installation.

The Contractor shall install the camera controller in the designated space of the ITS Cabinet. The Contractor shall install any associated camera equipment per the manufacturer's requirements and as shown on the Plans.

ii. Wiring and Connections.

Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

b. Cables and Electrical Power Service.

The Contractor shall install the conduit for electrical cable between the service pole and the ITS Cabinet load center. Electrical Power Service shall conform to the requirements of **Sub-Article 729.03(m)** and **Article 893.13, *"Electrical Power Service and Transformer"***.

All camera data shielded cables shall be routed separate from any 120 Vac or greater power wiring or surge suppressor ground wiring. "Power-Over-Ethernet" (POE) communications cables shall be permitted where installation and cable is in accordance with NEC Chapter 8.

Cable, shield or conductor used for camera control, power supply, or grounding shall not be spliced.

c. Interface Protocol.

The Contractor shall provide the Engineer with the manufacturer's open software interface/protocols for the Camera so that it can be fully integrated into the Department's current ALGo ATMS software.

d. Manufacturer's Software.

The Contractor shall provide the manufacturer's configuration and diagnostic software along with all licenses, software installation media and documentation/manuals to the Engineer at the completion of the Burn-In. Any special camera configurations or firmware updates shall also be delivered to the Engineer with this package.

(f) Vehicle Detection Systems (VDS).

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working VDS as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

The Contractor shall provide a VDS installation complete with associated detection equipment, control equipment, power, and communications equipment as shown on the Plans and as specified within the Specifications. The Contractor shall provide an installation kit with mounting brackets, data cables, power cables, hardware and any incidentals required by the manufacturer.

The Contractor shall maintain full responsibility for the VDS housing mounting to the support structure and confirm that the VDS can be properly mounted on the support structure prior to installation. The Contractor shall securely mount the VDS on the support structure. The VDS shall be constructed and shall be adjusted to obtain optimum function of the VDS.

The VDS, cabinet, and other components shall be mounted at locations as shown on the Plans. The Contractor is responsible to ensure that the VDS does not interfere with the operation of any other ITS electronic equipment when installed.

The Contractor shall be responsible for VDS configuration and setting up initial pre-sets using the manufacturer's software.

a. Cabinet Equipment.

i. VDS Controller Cabinet Installation.

The ITS Cabinet for remote control of the VDS from ground level shall conform to the requirements in **Sub-Article 729.03(l)** and **Article 893.12, *"ITS Cabinet"***. The ITS Cabinet shall be installed at locations as shown on the Plans unless otherwise designated and approved by the Engineer.

The Contractor shall install the VDS controller in the designated space of the ITS Cabinet. The Contractor shall install any associated VDS equipment per the manufacturer's requirements and as shown on the Plans.

ii. Wiring and Connections.

Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

b. Cables and Electrical Power Service.

The Contractor shall install the conduit for electrical cable between the service pole and the ITS Cabinet load center. Electrical Power Service shall conform to the requirements of **Sub-Article 729.03(m)** and **Article 893.13, *"Electrical Power Service and Transformer"***.

All VDS data cables shall be routed separate from any 120 Vac or greater power wiring or surge suppressor ground wiring.

Cable, shield or conductor used for VDS control, power supply, or grounding shall not be spliced.

c. Interface Protocol.

The Contractor shall provide the Engineer with the manufacturer's open software interface/protocols for the environmental sensor.

d. Manufacturer's Software.

The Contractor shall provide the manufacturer's configuration and diagnostic software along with all licenses to the Engineer at the completion of the Burn-In.

2. Radar Vehicle Detection System (RVDS).

Structure mounted equipment shall be installed per the manufacturer's recommendations for elevation and orientation.

After installation, the RVDS shall be tested for accuracy by comparing data collected by the RVDS to manual count data under the conditions as specified within the Specifications or as approved by the Engineer to verify the RVDS is operating within the accuracy requirements as specified within the Specifications.

3. Magnetometer Vehicle Detection System (MVDS).

In ground magnetometer units shall be installed per the manufacturer's recommendations for depth, orientation, and sealant. Structure mounted equipment shall be installed per the manufacturer's recommendations for elevation and orientation.

After installation, the MVDS shall be tested for accuracy by comparing data collected by the MVDS to manual count data under the conditions as specified within the Specifications or as approved by the Engineer to verify the MVDS is operating within the accuracy requirements as specified within the Specifications.

4. Bluetooth Data Collection System (BDCS).

Structure mounted equipment shall be installed per the manufacturer's recommendations for elevation and orientation.

After installation, the BDCS shall be verified as operational by confirmed matches of discoverable and/or non-discoverable Bluetooth devices between two BDCS locations for travel time purposes.

(g) Dynamic Message Sign (DMS).

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working DMS as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

The Contractor shall provide a DMS installation complete with associated control equipment, 120 Vac power, and communications equipment as shown on the Plans and as specified within the Specifications. The Contractor shall provide an installation kit with mounting brackets, data cables, power cables, hardware and any incidentals required by the manufacturer.

The Contractor shall maintain full responsibility for the sign housing mounting to the support structure and confirm that the sign can be properly mounted on the sign support structure prior to installation. The Contractor shall securely mount the sign on the sign support structure. Initially, the Contractor is to set the housing at a 3 degree tilt forward toward traffic and adjust the housing

under both day and night conditions to optimize the view of the sign from the roadway by a motorist and eliminate random reflections as directed by the Engineer. Alternatively, the housing may be constructed at a 3-degree tilt toward traffic, if approved by the Engineer, but shall be adjusted to obtain the same optimization of the viewing of the sign from the roadway.

The Contractor shall attach and secure all mechanical hardware for initial attachment prior to the reopening of lanes to traffic. The Contractor shall complete attachment of hardware prior to the release of crane cables. The Contractor shall also install and connect the DMS wiring and communications cables to the ground cabinet and disconnect switch in the controller cabinet only after attaching and securing the sign to the sign structure.

During the Acceptance Testing, the Engineer will evaluate the initial setting of the sign and direct the Contractor to adjust the sign tilt if necessary. The Contractor shall use nylon stop washers with mounting attachments. For all structural aspects, stainless lock washers and nuts are unacceptable; use stainless steel nuts with nylon inserts for locking.

The Contractor will lift and install the DMS housing and display in place on the overhead structure only with prior approval of, and in the presence of the Engineer. Do not lift and install the DMS housing and display until all equipment, materials, and labor are available such that the DMS can be operated with messages from the local DMS controller within 72 hours of installation on the overhead structure. The Contractor shall only program message displays on the DMS at the direction of the Engineer. Make sight alignment adjustments to the DMS housing and display as directed by the Engineer.

Securely install mounting hardware to the torque recommended by the overhead sign support manufacturer.

The DMS shall be mounted at locations shown on the Plans. The DMS shall be mounted using the manufacturer supplied mounting brackets.

The Contractor is responsible to ensure that the DMS does not interfere with the operation of any other ITS electronic equipment when installed.

The Contractor shall be responsible for DMS configuration and setting up initial pre-sets using the manufacturer's software.

a. Photosensor System.

The Contractor shall aim one sensor in the northerly direction (away from nearby lights) and scale it for a reading of up to 100 lux (horizon type). The other two sensors shall be aimed in opposite directions and perpendicular to the sign face. These two sensors shall be scaled for a reading of up to 100,000 lux. The sensors are to be mounted on the top of the housing near the right side for ease of maintenance. The aiming angle of the sensors shall be adjustable. The Contractor shall aim the photosensors and calibrate the dimming system consistent with field conditions found for each sign as a part of the installation process. This work is to be completed prior to any Acceptance Testing.

b. Cabinet Equipment.

i. Controller Cabinet Installation.

The ITS Cabinet for remote control of the DMS from ground level shall conform to the requirements in **Sub-Article 729.03(l)** and **Article 893.12, *"ITS Cabinet"***. The ITS Cabinet shall be installed at locations as indicated on the Plans unless otherwise designated and approved by the Engineer. The ITS Cabinet shall be mounted to the support pole(s) at a height of 42 inches {107 cm} from ground level to the bottom of the cabinet housing and shall be easily accessed by maintenance personnel.

The Contractor shall install the DMS controller unit in the designated space of the ITS Cabinet. The Contractor shall install any associated DMS equipment per the manufacturer's requirements and as shown on the Plans.

ii. Wiring and Connections.

Make all connections to terminal boards or screw-type equipment terminals with insulated fork-tongue compression connectors only when using stranded cable. Make all wiring to bulkhead connectors on equipment housings with MS bayonet-type connectors. Solder connector joints for use with extra-low voltage systems, with the joint metals preheated to the flow temperature of the solder or crimped using ratchet-type positive crimp tools and a double crimp (conductor and jacket) connector.

Remove the outer jacket of data and communications cables to expose approximately 6 in. {150 mm} of the shielding or drain wire. Twist together and solder the shielding or drain wire for

all cables serving a similar function with a 10 AWG minimum insulated (green jacketed) ground lead securely connected to the cabinet ground bus. Make the ground lead routing as short as possible. Cut the shield off and leave it isolated at the other end.

Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

The controller will be powered from the power distribution assembly provided in the ITS Cabinet. Bond the shields of all extra-low voltage cables to the ground bus inside the cabinet. The shield inside the sign enclosure shall be unconnected and insulated. Route low voltage cables and extra-low voltage cables installed in the cabinet on opposite sides of the cabinet. Group similar extra- low voltage cables in the controller cabinets, between common locations, together with cable ties.

Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

c. Cables and Electrical Power Service.

The Contractor shall install the conduit for electrical cable between the service pole and the ITS Cabinet load center. Electrical Power Service shall conform to the requirements of **Sub-Article 729.03(m)** and **Article 893.13, *"Electrical Power Service and Transformer"***.

All DMS data cables shall be routed separate from any 120 Vac or greater power wiring or surge suppressor ground wiring.

Cable, shield or conductor used for DMS control, power supply, or grounding shall not be spliced. The shield of low voltage instrumentation cables shall be grounded at one end only.

d. Use and Operations of DMS Prior to Final Acceptance.

The Department will approve or control any and all DMS displays at all times that a display is in potential public view to ensure compliance with current MUTCD. When potential public view exists, no message or graphical display of any kind or activation of any DMS display component is permitted without prior approval of the Engineer. At such time as the Engineer determines that any given DMS is ready for Department control, the Department will exercise complete and total control of that DMS display and all central and local communications with that local DMS controller. Prior to any action, coordinate with the Engineer any remaining work or any testing or maintenance that may affect that DMS display. Do not interpret such DMS display control as acceptance of the project in whole or in part. Do not construe such action as a waiver by the Engineer of any provision of this Specification. Do not consider such use part of the Burn-In Period.

e. Interface Protocol.

The Contractor shall provide the Engineer with the manufacturer's open software interface/protocols for the DMS.

f. Manufacturer's Software.

The Contractor shall provide the manufacturer's configuration and diagnostic software along with all licenses to the Engineer at the completion of the Burn-In.

2. DMS Supporting Structure.

Supporting Structure used for mounting the DMS and equipment shall conform to the requirements given in **Sections 715, 717,** and **718**.

For each DMS, the Contractor shall provide a complete Supporting Structure design which shall include all structural dimensions for the supporting structure and associated foundations.

a. DMS Housing Structural Design.

Professional Engineer calculations and a complete set of sealed DMS housing drawings shall be included within the DMS manufacturer's submittal to the Engineer. [See **Item 893.07(a)3, *"Material and Process Standards"*** and **Item 893.07(a)4, *"Sign Housing"*** for special material submittal requirements regarding: (a) Professional Engineer Certification of DMS Housing Structural Design and (b) welding inspection certification.]

A lifting mechanism shall be provided for transporting and installing the DMS and shall be a permanent, integral part of the DMS housing structural frame. Professional Engineer analysis of the DMS housing design shall include a certification of the DMS lifting mechanism.

3. Concrete Foundation.

The Contractor shall submit Concrete Foundation design for each DMS Supporting Structure in accordance with **Section 718**. The foundation design shall include all dimensions and reinforcing steel configuration.

The Contractor shall contact the Utility Companies to determine the location of underground utilities in the area where the foundations are to be located. The Contractor shall be responsible for repairing, to the satisfaction of the Utility Company, any utilities damaged by the Contractor.

4. DMS Acceptance Test.

The Contractor shall perform Acceptance Test on the DMS and ITS electronic equipment installed under this Project and have materials specified within this Specification. The Acceptance Test shall be in accordance with **Sub-Article 729.03(r), *"Testing"***.

The Visibility Inspection of the Field Test shall include the continuous display of a test message on each sign for a period of twenty 24-hour days. If any sign fails unacceptably (traveling motorist cannot recognize the test message) to complete the 20 day Burn-In due to component failure, the component shall be replaced and the 20 day Burn-In Period shall be started again from day one.

Acceptable failures are those that do not inhibit the motoring public from message recognition. Any component failures that occur within the acceptable failure shall be replaced prior to final acceptance.

The Field Test of the Acceptance Test procedure shall prove that Central and Field Controller software comply with the Specifications, and it shall demonstrate that all DMS system equipment is fully integrated and operational.

The Field Test procedure shall include the successful exercising of all diagnostic features provided with the DMS. Testing of the DMS Central Software and Computer shall include demonstrating proper data transfer to and from each remote site.

(h) Environmental Sensor.

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working environmental sensor as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

The Contractor shall provide an Environmental Sensor installation complete with associated control equipment, 120 Vac power, and communications equipment as shown on the Plans and as specified within the Specifications. The Contractor shall provide an installation kit with mounting brackets, data cables, power cables, hardware and any incidentals required by the manufacturer.

The Contractor shall maintain full responsibility for the sensor housing mounting to the support structure and confirm that the sensor can be properly mounted on the support structure prior to installation. The Contractor shall securely mount the sensor on the support structure. The sensor shall be constructed and shall be adjusted to obtain optimum function of the sensor.

The sensor, cabinet, and other components shall be mounted at locations as shown on the Plans. The Contractor is responsible to ensure that the sensor does not interfere with the operation of any other ITS electronic equipment when installed.

The Contractor shall be responsible for environmental sensor configuration and setting up initial pre-sets using the manufacturer's software.

a. Cabinet Equipment.

i. Controller Cabinet Installation.

The ITS Cabinet for remote control of the environmental sensor from ground level shall conform to the requirements in **Sub-Article 729.03(l)** and **Article 893.12, *"ITS Cabinet"***. The ITS Cabinet shall be installed at locations as shown on the Plans unless otherwise designated and approved by the Engineer.

The Contractor shall install the environmental sensor data processing unit in the designated space of the ITS Cabinet. The Contractor shall install any associated environmental sensor equipment per the manufacturer's requirements and as shown on the Plans.

ii. Wiring and Connections.

Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

b. Cables and Electrical Power Service.

The Contractor shall install the conduit for electrical cable between the service pole and the ITS Cabinet load center. Electrical Power Service shall conform to the requirements of **Sub-Article 729.03(m)** and **Article 893.13, *"Electrical Power Service and Transformer"***.

All environmental sensor data cables shall be routed separate from any 120 Vac or greater power wiring or surge suppressor ground wiring.

Cable, shield or conductor used for environmental sensor control, power supply, or grounding shall not be spliced.

c. Interface Protocol.

The Contractor shall provide the Engineer with the manufacturer's open software interface/protocols for the environmental sensor.

d. Manufacturer's Software.

The Contractor shall provide the manufacturer's configuration and diagnostic software along with all licenses to the Engineer at the completion of the Burn-In.

(i) Highway Advisory Radio (HAR).

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working HAR as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

The Contractor shall provide a HAR installation complete with associated control equipment, power, and communications equipment as shown on the Plans and as specified within the Specifications. The Contractor shall provide an installation kit with mounting brackets, data cables, power cables, hardware and any incidentals required by the manufacturer.

The Contractor shall maintain full responsibility for the HAR housing and antenna mounting to the support structure and confirm that the HAR can be properly mounted on the support structure prior to installation. The Contractor shall securely mount the HAR on the support structure. The HAR shall be constructed and shall be adjusted to obtain optimum function of the HAR.

The HAR, cabinet, and other components shall be mounted at locations as shown on the Plans. The Contractor is responsible to ensure that the HAR does not interfere with the operation of any other ITS electronic equipment when installed.

The Contractor shall be responsible for HAR configuration and setting up initial pre-sets using the manufacturer's software.

a. Cabinet Equipment.

i. Controller Cabinet Installation.

The ITS Cabinet for remote control of the HAR from ground level shall conform to the requirements in **Sub-Article 729.03(l)** and **Article 893.12, *"ITS Cabinet"***. The ITS Cabinet shall be installed at locations as shown on the Plans unless otherwise designated and approved by the Engineer.

The Contractor shall install the HAR controller in the designated space of the ITS Cabinet. The Contractor shall install any associated HAR equipment per the manufacturer's requirements and as shown on the Plans.

ii. Wiring and Connections.

Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

b. Cables and Electrical Power Service.

The Contractor shall install the conduit for electrical cable between the service pole and the ITS Cabinet load center. Electrical Power Service shall conform to the requirements of **Sub-Article 729.03(m)** and **Article 893.13, "*Electrical Power Service and Transformer*"**.

All HAR data cables shall be routed separate from any 120 Vac or greater power wiring or surge suppressor ground wiring.

Cable, shield or conductor used for HAR control, power supply, or grounding shall not be spliced.

c. HAR Antenna Grounding.

The HAR antenna grounding design and design submittal shall be either conducted by or signed off by the HAR equipment manufacturer. The Contractor's HAR submittal package shall include antenna and grounding details showing design configuration and proposed equipment and materials, supporting design calculations, recommended installation methods/procedures to be utilized, and equipment and proposed material specifications/cut-sheets.

d. Interface Protocol.

The Contractor shall provide the Engineer with the manufacturer's open software interface/protocols for the environmental sensor so that it can be fully integrated.

e. Manufacturer's Software.

The Contractor shall provide the manufacturer's configuration and diagnostic software along with all licenses to the Engineer at the completion of the Burn-In.

(j) Conduit, Conductor, Locate Tone Wire, Warning Tape, and Messenger.

Work shall be performed in accordance with the highest industry standards, meeting the requirements of the latest editions of the NEC, NESC, and NEMA.

1. Installation of Buried Duct and Conduit.

Conduit shall be installed by means of open trenching, plowing, or precision directional boring. Spare conduit shall have Pull Tape installed in the duct. Maximum spacing between supports and spacing between expansion fittings shall be as shown on the Plans or, if not shown, according to the manufacturer's recommendations.

If rocky soil conditions are encountered during precision directional bore installations, SDR-9 HDPE conduit may be required as approved by the Engineer.

Coiled non-metallic conduit shall be treated by a line tamer prior to underground (or below grade) installation.

If more than one run of underground conduit is required, install in one trench unless in conflict with NEC requirements.

Extend conduit ends 2 inches {51 mm} above concrete surfaces and 4 inches {100 mm} above crushed stones bases; and install with bushings. For metallic conduit, install metallic bushings. For non-metallic conduit, install non-metallic bushings. Where conduit connects to a panel, box, or other enclosure, use a locknut in addition to the bushing.

Where non-metallic conduits join metal conduits, connection shall be made using appropriate couplings to form a watertight raceway.

All conduits entering concrete foundations shall be provided with appropriate bushings at the ends. Conduits shall be stubbed approximately 2 inches {51 mm} above concrete and shall be provided grounding type bushings on conduit ends in the base of poles with copper bonding jumpers.

Bends and offsets shall be avoided where possible, but where necessary, shall be made with a proper pipe bender or conduit bending machine. Conduit that has been crushed or deformed due to improper bending or handling shall not be installed.

Surface damage to RMC conduit shall be repaired in accordance with the Specifications. Exposed threads shall be regalvanized.

After installation, conduits shall be tested for clearance with a 2-inch long mandrel (a.k.a., pig) having a diameter 1/4 inch smaller than the inside diameter of the conduit. Conduits not allowing passage of the mandrel shall be rejected.

After placement of conduit, all conduits shall be capped to prevent moisture or foreign matter from entering until the fiber optic cable or conductor installation is started. Upon installation of fiber

optic cable and/or conductor, conduit ends shall be sealed with duct sealer. Duct sealer shall be a water-blocking, closed-cell, easily removable/re-enterable, polyurethane foam material as recommended by the cable manufacturer and approved by the Engineer. Duct sealer shall be identified for use with the fiber optic cable and conductor insulation; and should not cause deterioration of the insulation over time. For underground conduit adjacent to gasoline service stations or other installations of underground gasoline or diesel storage, piping or pumps, and which lead to a cabinet, circuit breaker panel, service or any enclosure where an arc may occur during normal operation, the Contractor shall refer to the NEC for Class 1, Hazardous Locations.

2. Installation of Hanging Duct and Conduit.

Maximum spacing between supports and spacing between expansion fittings shall be as shown on the Plans or, if not shown, according to the manufacturer's recommendations.

The conduit system shall include mechanisms such as expansion fittings or joints to ensure that the expansion and contraction stresses are normalized. Spacing or expansion fitting shall be based upon manufacturer standards for the location conditions/environment of the installation.

After placement of conduit, all conduits shall be capped to prevent moisture or foreign matter from entering until the fiber optic cable or conductor installation is started. Upon installation of fiber optic cable and/or conductor, conduit ends shall be sealed as permitted by the current NEC. If duct sealer is allowed and used, then the duct sealer shall be a water-blocking, closed-cell, easily removable/re-enterable, polyurethane foam material as recommended by the cable manufacturer and approved by the Engineer. Duct sealer shall be identified for use with the fiber optic cable and conductor insulation; and should not cause deterioration of the insulation over time.

The Contractor shall be fully responsible in the event defective conduit is installed and shall be held fully responsible for replacement (material and labor) of any conduit found to be defective due to manufacture error, improper construction, or improper installation for one year after the State's acceptance of the project.

a. Installation of RTRC.

The conduit shall be packaged for shipment at the factory. The conduit shall be assembled into manageable bundles. Each section of conduit shall be shipped with protective caps over each end of the section. Conduit that arrives at the job site without the protective cover in place over both ends will be rejected by the Engineer.

Conduit connections for RTRC shall be sealed with epoxy adhesive. Joints for RTRC shall be joined until the conduit ends are together. Once connected the joint pullout rating shall be equal to the tensile strength of the conduit. No reducing couplings shall be permitted in a conduit run.

b. Installation of RMC.

The conduit shall be packaged for shipment at the factory. The conduit shall be assembled into manageable bundles. Each section of conduit shall be shipped with protective caps over each end of the section. Conduit that arrives at the job site without the protective cover in place over both ends will be rejected by the Engineer.

3. Installation of Conductor.

On projects where a conductor(s) and/or electrical cables are to be mechanically or hand pulled, a "*Pull Tape*" as specified in **Sub-Article 893.10(d)** shall be factory or field installed within conduit for the purpose of attaching to, and the pulling of said conductor/cable. PULL ROPES NOT SPECIFICALLY DESIGNED FOR FIBER OPTIC AND ELECTRICAL CABLE INSTALLATION SHALL NOT BE USED ON ANY ALDOT PROJECT.

Conductors shall have the appropriate identification on the outer jacket. Conductors not meeting this requirement or with illegible identification are not allowed.

Wiring within pull boxes and CommBoxes shall be neatly arranged and labeled/tagged. All ends of hardwire shall be taped to exclude moisture and shall be so kept until splices are made and terminal appliances attached.

The ends of spare conductors shall be protected as permitted by the current NEC (capped method is preferred). End of fiber optic cables shall be protected from moisture by methods as shown on the Plans or as approved by the Engineer.

Splices and taps in electrical conductors shall only be made in pull boxes, CommBoxes and pole bases. They shall be made with solderless split bolt connectors. Splices and taps shall be protected and sealed in silicone gel filled enclosures to provide a waterproof connection and to ensure the required electrical insulation. Silicone gel filled enclosures shall be re-enterable; shall be ultra-violet

(UV) resistant, listed for temperatures from -40˚F to 194˚F {-40˚C to 90˚C}; and shall be impact and abrasion resistant. The enclosure shall be sized as shown in the following table:

CONDUCTOR SIZE	GEL ENCLOSURE SIZE
4 AWG and smaller	#2
2 AWG	#2.5
Larger than 2 AWG	#3

Installation of conductors shall be in accordance with the NEC. Conductors shall not be pulled into a conduit until the installation of the conduit is complete. Prior to the installation of conductors, the Contractor shall ensure the conduit is free of water and debris by blowing air and pulling a foam ball, mandrel, or brush through the conduit. The ends of conduit shall be cleaned of bures and capped with a bushing to protect cables during installation.

Conductors in conduits shall be carefully pulled into place using approved methods so that the conductors will not be damaged. Powdered soapstone, talc, or other inert lubricant specifically designed for the purpose shall be used when pulling conductors through the conduit. All conductors within a single conduit shall be pulled at the same time; and, shall be handled and installed in such a manner as to prevent kinks, bends or other distortion which could damage the conductor and outer covering. When conductors are pulled through hand holes, pole shafts, etc., a pad of firm rubber or other suitable materials shall be placed between the conductors and the edges of the opening to prevent damage to the conductors.

The pulling tension on conductors shall not be exceeded. Friction reduction multiduct pulling sleeves may be used as an alternate to lubricant. The Contractor shall not exceed the NEC conduit fill capacity requirements. Fiber optic cables shall not be installed in conduits containing current carrying conductors.

4. Installation of Locate Tone Wire.

Locate Tone Wire shall be installed along the entire underground conduit run for non-conductive fiber optic cables in accordance with this Specification and as shown on the Plans. Ensure that the Locate Tone Wire enters all CommBoxes and Pull Boxes as the fiber optic cable; and, that a minimum of 10 feet {3 meters} of slack is coiled and neatly stored in each box. Locate Tone Wire shall be suited for direct burial and shall be continuous.

Locate Tone Wire system does not require to be grounded since it is a non-current carrying conductor used for locating fiber optic cable only. Locate Tone Wire shall not be installed inside ITS Cabinets.

Where fiber optic conduit is installed via trenching operation, the Locate Tone Wire is to be installed no more than 3 inches {7.62 cm} above the conduit. Where fiber optic conduit is installed via boring operation, the Locate Tone Wire is to be installed in an encasement so that the Locate Tone Wire is external to the conduit with no separation between conduit and wire. Locate Tone Wire may also be placed in the void between the inner wall of encasement and inner conduits contained within the encasement as long as no other cables are present within the void.

Locate Tone Wire may be installed inside conduit only when non-armored fiber optic cable is the only other cable within the conduit for ease of utility locating.

The Contractor shall perform the Circuit Continuity Test and Insulation Test, as defined within this Specification, on all Locate Tone Wires. The Contractor shall document and provide the test results to the Engineer upon completion of these tests. The Contractor shall replace or repair defective Locate Tone Wire at no additional cost to the Department.

5. Installation of Messenger Wire.

The Contractor shall furnish and install messenger wire, aerial lashing, down guy, mounting hardware and fittings, insulators, and all other materials necessary to provide a support for fiber optic and electrical service cables. Messenger wire shall be attached to poles at the locations as shown on the Plans. Installations shall conform with all applicable NEC, NEMA and NESC requirements, along with any special Utility Company pole attachment requirements for the pole being attached. The suspension strand shall be placed on the roadside of the pole line unless otherwise directed by the Engineer.

The installation of messenger wire shall meet all requirements of the National Electrical Safety Code (NESC) regarding clearance from electrical lines and adjacent utility lines.

The Contractor shall be responsible for locating and drilling all holes required for the attachment of the messenger wire to the poles. The Contractor shall not use any existing holes on utility poles without prior authorization of the Engineer. Re-use of existing cable attachment hardware shall not be permitted.

The Contractor shall install messenger wire in continuous segments from pole to pole except where reel splice is required. Where splices are necessary, the Contractor shall maintain absolute minimum number of splices for total length of run. Prior approval for these messenger wire splices is required from the Engineer. The Contractor shall tension the unloaded messenger wire in accordance with the recommendations of the messenger wire and fiber optic cable manufacturers, to minimize the possibility of strand fatigue failure.

The length of the messenger wire shall be adjusted to ensure the vertical sag is not greater than a two percent of the length between the support poles once loaded with fiber optic cable. Each messenger wire shall be attached to the supporting structure with separate span wire clamps.

The messenger wire shall be grounded at all pole locations where attached in accordance with NESC and the pole owner's requirements. The Contractor shall not use existing Utility Company grounds. The messenger wire shall be bonded with bonding conductors and clamps to the pole's ground conductor. For poles without an existing grounding system, the Contractor shall install grounding electrodes. The messenger wire shall be bonded at maximum intervals of 1300 feet {396 m}.

6. Installation of Guy Wire.

Guy wire (a.k.a. down guy) shall be installed where there is room on the pole to install a ~~Teo~~ bolt attachment in compliance with the National Electrical Safety Code (NESC). Attach the guy assembly and the guy cable to two separate bolts with one bolt for the span and one bolt for the guy cable. Provide 8 to 12 inch {200 to 300 mm} separation between bolts or as required by the owner.

The back guy (down guy) shall be installed, wherever possible, to provide a minimum rise of 2 and run of 1.

Anchor holes should be dug to such depths that no more than approximately 6 inches {153 mm} of anchor rods should be above ground after the strain is applied by the guys. Anchors should be in line with the guys.

Install guy wire prior to installation of messenger wire and lashed fiber optic or electrical service cable. The Contractor shall determine the guy locations and shall show each location to the Engineer prior to installation of guy. Not more than 6 inches {153 mm} of rod shall remain out of the ground after the load is applied.

Down guy shall have a guy marker (a.k.a. guy guard) installed in accordance with applicable NESC, NEMA and local Utility standards.

The Contractor shall be wholly responsible for the direct interface with the Utility Company whose pole is to be shared. The Contractor shall submit the drawing representing the aerial cable installation to the said utility for that Utility Company's determination and approval of the down guys which may be required on each project. All guys and guying plans shall also adhere to the NESC. Final guying plans shall be submitted for approval to the Engineer prior to the commencement of installation.

7. Installation of Warning Tape.

For Type 1 "Open Trench" Conduit Installations, the Contractor shall place the warning tape within the same ground cut (ditch) as the conduit and locate tone wire as shown on the Plans. Once the conduit and locate tone wire are placed, the cut/ditch shall then be backfilled up to a point no more than 12 inches {305 mm} below grade and at a maximum of 6 inches {152 mm} below grade where the Contractor shall then apply on continuous, unbroken length of the warning tape between the CommBoxes. The cut/ditch shall be completely filled in and prepared to its original state or as specified by the Engineer.

For Type 5 "Directional Bore" Conduit Installations, the warning tape shall not be required unless otherwise indicated on the Plans.

(k) Grounding, Lightning Protection, Insulation, and Circuit Continuity.

1. General.

Grounding electrodes (rods) shall be installed at all service equipment, cabinets, CommBoxes, Pull Boxes, and pole foundations as shown on the Plans or as required by the Engineer and in accordance with the NEC and NESC. CommBoxes and Pull Boxes require grounding electodes only when armored fiber optic cables or electrical service conductors are being installed in said box [see

Item 729.03(q)4, *"Installation of CommBox and Pull Box"*]. Hub Building and Generator equipment shall be grounded in accordance with their respective manufacturer requirements and in accordance with the NEC and NESC. The ground resistance value shall meet the values as defined within this Specification.

All metal enclosures, metallic conduits, raceways, armored fiber optic cable, and METALLIC junction boxes containing electric wires and equipment shall be bonded together and grounded to earth through the grounding electrode system.

The ITS Cabinet grounding system shall be isolated from any other grounding system, including a support pole grounding system.

The locate tone wire system shall be isolated from any other grounding system and shall not be extended into a cabinet or building [see **Item 729.03(j)4, *"Installation of Locate Tone Wire"***].

Ground busbars shall be provided in equipment racks, enclosures, buildings, and structures as necessary.

Single grounding electrodes (rods) shall be driven vertically until the top of the electrode (rod) is at least 12 inches {305 mm} below the finished grade.

Where a grounding conductor passes through a metal conduit, a suitable grounding bushing shall be placed on each end of the conduit and connected to a ground wire.

A grounding conductor, either bare or having a green colored insulation, shall be extended from the service ground to all equipment and shall be used for grounding purposes only. The grounding conductor must be installed in one continuous length.

Exposed grounding electrode conductors shall be protected against physical damage. Unless otherwise indicated on the Plans or in these Specifications, the grounding electrode conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, pressure connectors or clamps.

The ground conductor shall be isolated and insulated from any utility grounding equipment.

2. Grounding for Electrical Power Service.

For Electrical Power Service and in addition to the above general grounding requirements, the Contractor shall install grounding electrode conductor (ground wire) up the wood pole to a point adjacent to the uppermost span. This grounding electrode conductor shall be secured to the wood pole with hot-dipped galvanized wire staples on 12 inch {300 mm} centers from ground level to 8 feet {2.4 m}. Above 8 feet {2.4 m}, wire staples are to be installed on 24 inch {600 mm} centers.

Grounding electrode(s) (ground rod) shall be installed at the base of the pole and exothermically weld the grounding electrode conductor (wire) to the grounding electrode (rod).

The messenger wire shall be bonded to the grounding electrode conductor using a clamp.

3. Lightning Protection.

Lightning Protection shall be installed as shown on the Plans at all poles greater than or equal to 75 feet {22.8 m} in height and at Overhead Sign Structures.

4. Insulation Testing.

The Insulation Testing (a.k.a. Isolation Test) shall be performed for each conductor in the cable to determine insulation resistance. These tests shall be performed using the NEC as a guide. Any connected ITS devices/equipment are to be removed prior to testing to prevent damage. Any reading of less than 250,000 ohms to ground is unacceptable and shall be corrected. The Contractor shall remove the defective cable, install new cable, and the test be repeated. These insulation resistance tests shall be conducted in the presence of the Engineer.

5. Circuit Continuity Test.

The Contractor shall perform Circuit Continuity Tests. Each branch circuit shall be temporarily jumpered at its termination and the temporarily loop circuit measured for continuity to assure that no open circuits exist, that the branch circuit is according to Plan, that no high resistance connections exist and that each circuit is properly identified. Each circuit shall be marked with typed labels.

6. Ground Resistance Test.

At each grounding electrode (rod) location, a resistance to ground test shall be conducted by the Contractor in the presence of the Engineer. This test shall be conducted using a null balance earth tester with two auxiliary ground rods placed 50 ft and 100 ft {15 m and 30 m}, respectively, from the tested grounding electrode (rod). A reading of **5 ohms (Ω) or less** is satisfactory. Any reading greater than 5 ohms (Ω) will require the installation of additional grounding electrodes (rods) to be placed in a pattern as shown on the Plans and in accordance with the NEC. After adjustments in the grounding

electrode (rod) configuration, the test shall be repeated (and grounding electrode configuration adjusted) until a reading of 5 ohms (Ω) or less is obtained or to the satisfaction of the Engineer.

If a ground resistance measurement of 5 ohms or less cannot be achieved with the addition of grounding electrodes totaling 80 feet in length, the Engineer may accept this 80 feet of grounding electrodes where soil conditions prevent the grounding system from achieving the 5 ohms value so long as the test results meet NEC requirement of no more than 25 ohms.

Commbox with conductive optical fiber cables or electrical service conductors shall be grounded in accordance with the NEC. A reading of **25 ohms (Ω) or less** is satisfactory. Any reading greater than 25 ohms (Ω) will require the installation of additional grounding electrodes (rods) as detailed above. These cables shall be bonded together and grounded to earth through the grounding electrode in accordance with these specifications and the NEC.

Commbox with non-conductive optical fiber cables and locate tone wire installed will not require a grounding system installed.

For aerial installations requiring a messenger wiring system, a grounding electrode shall be installed in accordance with these grounding requirements and **Item 729.03(j)5, *"Installation of Messenger Wire"***. For this **messenger wire system,** a reading of **25 ohms (Ω) or less** is satisfactory unless otherwise directed by the pole owner and approved by the Engineer. Any reading greater than the specified ohms (Ω) resistance value will require the installation of additional grounding electrodes (rods) as detailed above.

Ground resistance test should not be performed after the earth surrounding the grounding electrodes (rods) has become wet due to weather or other means. Normal soil conditions and moisture content should be observed and noted on the ground resistance test results.

Ground enhancement materials (e.g. salts or other chemical treatments) are not to be allowed as an alternative in reaching the designated soil resistivity level.

The Engineer may require additional ground resistance testing to be performed after the completion of the Acceptance Test.

(l) Intelligent Transportation System (ITS) Cabinet.

1. General.

The Contractor shall assemble and install all necessary material and equipment and furnish a working ITS Cabinet as shown on the Plans and as specified within these Specifications.

ITS Cabinets shall be installed on poles, Overhead Sign Bridge (OHSB) Structures, mounting pads, or other methods as shown on the Plans and in accordance with these Specifications. Typically, ITS Cabinets are mounted on ITS poles except for DMS installations which are mounted on the OHSB structure supporting the DMS. ITS Cabinets being utilized as Hub Cabinets (i.e. fiber distribution hub application) are to be pad mounted.

All ITS Cabinets shall be furnished with mounting plates and other necessary hardware to mount the ITS Cabinet on a pole or foundation. The ITS Cabinet should be mounted as shown on the Plans or as directed by the Engineer. All items that are required to complete the ITS Cabinet installation shall be supplied by the Contractor.

ITS Cabinet installations shall include: power and communications run to and properly terminated within the cabinet; any required work and hardware to mount and/or anchor the cabinet; any fans, thermostat, or other electronic devices as shown on the Plans; any required patch cables for equipment housed within; any DIN rails, racks, or panels required for mounting or grounding equipment whether shown on the Plans or not; and any other equipment, materials, or labor needed to provide fully operational equipment within the cabinet housing.

ITS Cabinets being utilized as fiber optic hub cabinets shall also house the following: the trunk fiber optic cable storage and major routing points of the fiber optic network; the primary fiber distribution units; any required network switch gear; electrical power equipment; and various other devices. All hub cabinets shall be furnished with mounting plates and other necessary hardware to mount the ITS Cabinet on a foundation.

2. Wiring, Conductors and Terminal Blocks.

The Contractor shall enclose all cabling and wiring entering the cabinet housing in conduit. The Contractor shall securely and neatly dress all cabling and wiring inside the cabinet, including field wiring. The Contractor shall provide sufficient slack, minimum 2 feet {600 mm}, for cabinet equipment maintenance and re-termination of the field wiring. The Contractor shall route fiber drop cables into the cabinet to provide as much physical protection as possible; secure these drop cables through-out the cabinet; and strain-relieve these drop cables within the fiber termination unit.

The Contractor shall use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. All wiring and cabling shall be routed and secured to avoid sharp edges and to avoid conflicts with other equipment or cabling. Terminate all wiring on a terminal block, strip, busbar, or device clamp or lug; do not splice any wiring. Use a minimum 12 AWG for all conductors of 120 Volts AC circuits, unless otherwise shown on the Plans.

3. Surge Protection.

Surge-Protective Devices (SPDs) are required as defined in this Specification and shown on the Plans.

Surge-Protective Devices (a.k.a. surge suppression) shall be installed to protect all copper wiring and cabling entering the cabinet housing, except for the earth ground conductor. Terminate all wiring between cabinet devices and the transient surge suppressors, except for the video signal coaxial feed, on terminal strips. Use a minimum 16 AWG grounding of each surge-protective device, or larger if recommended by the surge-protective device manufacturer. Insulated green wire and connected the ground wire directly to the ground busbar. Do not "*daisy chain*" with the grounding wires of other devices including other surge suppressors. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the surge-protective device and the ground busbar. Label all surge-protective devices with silk-screened lettering on the mounting panel.

Use minimum 18 AWG insulated black wiring between the surge-protective device sockets and the terminal blocks for the protected circuits, or larger if recommended by the surge-protective device manufacturer.

4. Component Installation.

All components/devices of the ITS Cabinet assembly shall be rack mounted with Phillips-head machine screws. Install screws into tapped and threaded holes in the panels. These components/devices include but are not limited to terminal blocks, busbars, panel and socket mounted surge-protective devices, circuit breakers, accessory and equipment outlets, VDS interface, video encoders, fiber distribution units and field network switches. Fasten all other cabinet components with hex-head or Phillips-head machine screws installed with nuts (with locking washer or insert) or into tapped and threaded holes. These other components include, but are not limited to: door switches, fans, lights, thermostats, thermal blocks, and door lock mechanisms. Fasten stud-mounted components to a mounting bracket providing complete access to the studs and mounting nuts. All fastener heads and nuts (when used) shall be fully accessible with a complete ITS Cabinet assembly, and any component/device shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

5. Electrical Power Service.

The Contractor shall provide electrical power service in accordance with these Specifications and as shown on the Plans.

6. Grounding.

The Contractor shall provide the ITS Cabinet assembly with grounding and shall be connected upon ITS Cabinet installation in accordance with these Specifications and as shown on the Plans. The Contractor shall measure the resistance to ground at each ITS Cabinet location in the presence of the Engineer. Do not splice the ground conductor between the cabinet grounding terminal and the ground rod.

7. Mounting Brackets.

Where the ITS Cabinet is pole or structure mounted, the ITS Cabinet shall be installed utilizing mounting brackets and all appurtenances necessary in accordance with the Specifications and as shown on the Plans. ITS Cabinet shall not move or flex on the structure/pole once installed and with all equipment populated. Cabinet wall reinforcement by the cabinet manufacturer may be necessary.

8. Foundation (Mounting Pad).

Where the ITS Cabinet is pad mounted, a concrete mounting pad foundation shall be installed in accordance with the Specifications and as shown on the Plans.

9. Concrete Pad (Service Platform).

Where the ITS Cabinet is pole or structure mounted, a poured in place concrete pad shall be installed below the ITS Cabinet where the Plans show it as required. This concrete service platform pad shall be installed in accordance with the Specifications and as shown on the Plans.

(m) Electrical Power Service and Transformer.

The entity (City, County, State, etc.) that will be responsible for the eventual operation and maintenance of the fiber optic and/or ITS equipment will make application for electrical service upon notification that power service will be required. The Contractor shall inform the Engineer when power service is required at least 30 calendar days prior to the need of the electrical power service. This same entity will be responsible for the cost of the service connection and the monthly service billings thereafter.

The location of the utility service point and power source shown on the Plans is approximate. The Contractor shall determine the exact location, voltage, procedure, and materials required by the Utility Company. The Contractor shall obtain the Engineer's approval of this exact power/service location prior to installation.

When the service equipment is to be installed on a utility-owned pole, the Contractor shall furnish and install riser, conduit, conductors, and other necessary material to complete the installation of the service. The position of the riser and equipment will be determined by the Utility Company.

When the Contractor is to provide a lateral drop from the power source to the service pole, the Contractor shall arrange with the serving Utility Company to complete the service connections. The Contractor shall install the riser, conduit, conductors, enclosure and accessories, disconnect switch(es), meter base and service pole.

No cable used for power supply shall be spliced.

1. Service Pole (Wood Pole).

Service Pole (Wood Pole) shall be installed below grade a minimum depth equal to one-sixth the total pole height. Refer to AASHTO "*Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*", current edition.

All final pole locations shall be marked. The Engineer shall approve each location prior to the commencement of drilling of each hole.

When service pole is installed on a slope of 2:1 or greater, the installation depth shall be increase by 1 times the diameter of the pole (depth is to be measured from the down slope side of the pole.)

The backfill shall be native material in 1 foot {300 mm} lifts to match surrounding grade. Tamp each lift to 90 percent compaction.

Existing wood poles and required wood poles used to support messenger wire or to serve as the source of power shall be grounded.

2. Guy Wire.

Guy Wire (a.k.a. down guy) shall be installed in accordance with the requirements of this Section and as shown on the details in the Special and Standard Highway Drawings, unless otherwise shown on the Plans.

3. Transformer (Step-Up/Step-Down).

The Contractor shall provide step-up/step-down Transformers in accordance with these Specifications and as shown on the Plans.

(n) Intelligent Transportation System (ITS) Pole.

1. Installation and Handling.

The Contractor shall handle and install ITS poles (especially concrete poles) in accordance with the manufacturer's standard operating procedures, the requirements of **Section 718** and **Section 891**, and the following requirements:

a. Transportation, site handling and erection shall be performed by qualified personnel with acceptable equipment and methods.

b. ITS poles shall be lifted and supported during the manufacturing, stock piling, transporting and erection operations only at the lifting or support points, or both, as shown on the shop or erection drawings.

c. Erection drawings for each ITS pole shall be provided which identify the structure number, structure length, shipping weight, center of gravity and lifting points. Each ITS pole shall be clearly marked with the corresponding information.

d. Prior to unloading concrete ITS pole, shop drawings shall be reviewed to identify proper pick-up points for unloading, storage and erection procedures. A thru-hole may be provided at the proper single point pick-up location to enable a steel bar to be inserted as a safety stop for slings during the erection process (this bar is NOT a lifting device but serves only as a safety stop to prevent the sling from sliding).

e. Each ITS pole shall be vertical installed within 1/8 inch per 10 feet {3 mm per 3 m} of height.

f. The Contractor shall be responsible for digging holes for each concrete ITS pole. Concrete ITS poles shall be placed in hole using appropriate equipment and held in vertical position until backfill has been completed in order to maintain pole position.

2. Concrete Foundation.

For each ITS Pole that requires a concrete foundation, the Contractor shall submit Concrete Foundation design in accordance with **Section 718**. The foundation design shall

The Contractor shall notify the Engineer, who shall insure that conduit and elbows are securely attached, before concrete is poured.

The Contractor shall contact the Utility Companies to determine the location of underground utilities in the area where the foundations are to be located. The Contractor shall be responsible for repairing, to the satisfaction of the Utility Company, any utilities damaged by the Contractor.

3. Auger Base Foundation.

Auger Base Foundation (screw-in helix type) shall be for vehicle detection (i.e. radar and magnetometers) installations on metal ITS poles only as shown on the Plans and defined within these Specifications. Auger Base Foundation shall be installed by being augered into place per the manufacturer's installation and standard operating procedures. If the auger base foundation cannot be installed by augering and upon the Engineer's prior approval, the auger base foundation may be installed by being encased in concrete.

If recommended by the auger base manufacturer, a pilot hole may be used to facilitate the installation of an auger base foundation. The diameter and depth of the pilot hole shall not exceed the maximum dimensions as calculated and specified by the manufacturer.

Auger Base Foundation shall also conform to the installation requirements of **Section 718** and **Section 891**, except for the concrete encasement allowance option as defined in this Section.

The Contractor shall contact the Utility Companies to determine the location of underground utilities in the area where the foundations are to be located. The Contractor shall be responsible for repairing, to the satisfaction of the Utility Company, any utilities damaged by the Contractor.

(o) Hub Building.

1. General.

Hub Building components shall include, at a minimum, the following: hub building, foundation footing, HVAC system, interior electrical distribution system, lighting, fire extinguisher, lightning protection system, interior and exterior grounding, generator with automatic transfer switch, and other items as indicated within these Specifications and shown on the Plans. This work shall include site preparation, procurement, transportation, and installation of a Hub Building with conduit connections to the size and number of conduits specified on the Plans.

Hub Building shall be placed at the designated location on and anchored to the concrete slab with slab foundation being a minimum of 1 foot above grade, said slab supplied by the Contractor as per the Specifications and as shown on the Plans. All Hub Building joints are to be sealed as recommended by the building manufacturer.

The Contractor shall provide three (3) sets of Hub Building keys to the Engineer no more than 18 hours after Hub Building installation.

The required outside surface treatment (e.g. paving, graveling, etc.) and fencing around the Hub Building shall be paid under their respective pay items and as shown on the Plans.

2. Electrical Power Service.

The Contractor shall provide Electrical Power Service in accordance with these Specifications and as shown on the Plans. This includes a Generator with Automatic Transfer Switch and Uninterruptible Power Supplies (UPSs).

3. Gas Utility Service.

The Contractor shall provide Gas Utility Service in accordance with these Specifications and as shown on the Plans.

4. Grounding.

The Contractor shall provide grounding in accordance with these Specifications and as shown on the Plans.

5. Security Fence.

A security fence shall be installed around the Hub Building as shown on the Plans. The security fence and gate for the Hub Building will be paid for using other pay item(s) as shown on the Plans.

6. Hub Building Foundation.

A concrete foundation footing shall be installed in accordance with the Specifications and as shown on the Plans.

(p) Gas Utility Service.

The location of the utility service point and gas source shown on the Plans is approximate. The Contractor shall coordinate with the local gas Utility Company to determine the exact location, procedure, and materials required for each service point. The Contractor shall obtain the Engineer's approval of this exact service location prior to installation. Depending upon local codes, a permit may be required and is the responsibility of the Contractor.

The Contractor shall provide necessary items not provided by the local gas Utility Company to make said service connection to the Hub Building Generator and associated equipment. This typically includes the fuel line which consists of gas piping from the gas meter to the generator along with connection to the generator. The local gas Utility Company typically provides the meter set (gas meter along with a gas line pressure regulator if required) and the service line (piping from main distribution line to meter set). The gas service components are to meet or exceed applicable installation requirements of the American Gas Association (AGA), National Fuel Gas Code (NFGC), and the local gas Utility Company.

Gas Utility Service shall also conform to the requirements of **Section 646** and **Section 861**.

After Contractor completes the fuel line installation and prior to the Utility Company making connection; this gas utility service installation will be subject to inspection and approval as required by local codes.

The entity that will be responsible for the eventual operation and maintenance of the Hub Building (or other infrastructure requiring such utility as shown on the Plans) will make application for gas utility service upon notification that service will be required. The Contractor shall inform the Engineer when gas service is required at least 30 calendar days prior to the need of said service. After which, the Contractor may arrange with the serving gas Utility Company to complete the service connection. The Department's Area Office (or other entity as noted above or indicated on the Plans) will be responsible for the cost of the service connection by the Utility Company and the monthly service billings thereafter.

(q) Miscellaneous Infrastructure.

The Contractor shall assemble and install all necessary material and equipment and furnish working equipment as shown on the Plans and as specified within the Specifications. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor.

Wiring connections in poles shall be environmentally sealed using a minimum of watertight electrical connectors, mastic electrical splicing tape, and standard electrical tape.

1. Connector Termination Procedures.

The procedure to be used for the termination of the **SC** connectors used and shall meet that process set out in that connector manufacturer's Standard Operating Procedure for the field installation. Fiber optic connectors shall meet the assertion loss for connectors as specified within the Specifications.

The Contractor shall perform the final inspection of connector faces with a 200X scope.

2. Installation of Splice Closure (Underground and Aerial).

Splice Closures are required for housing and managing outside plant fusion splices, whether installed in underground or aerial applications.

When splicing inside a building or cabinet, a splice center shall be provided in rack or wall space utilizing fiber distribution units (FDUs) as indicated on the Plans and in accordance with **Article 729.03(c), "*Fiber Distribution Units (FDU), Connectors, and Fan-Out Kit*"**.

Splice Closure shall be installed per manufacturer's Standard Operating Procedure, whether installed underground or aerially.

The application and installation of an aerial splice closure shall be performed in such a manner as to allow complete splice access after closure placement. This access shall be without the removal of the closure or electrical bonds from the messenger wire. The splicing procedure and splice tray storage within the closure shall be performed in such a process as to allow for aerial re-entry and inspection of the closure.

The Contractor shall provide aerial splice closure with manufacturer recommended mounting hardware for attaching to the messenger wire. The Contractor shall not be allowed to mount any splice closures on utility poles.

The Contractor shall also provide and submit, for Engineer approval, the splice closure mounting hardware cut-sheets with the Material Submittal package.

3. Installation of Riser Assembly.

The Contractor shall furnish and install Riser Assembly in accordance with the Plans. The Riser Assembly shall consist of a metallic riser, backplates, mounting brackets, supports, any accessories, and required hardware as defined within the materials section and as shown on the Plans. The Riser Assembly shall be installed in conformance to the details shown on the Plans and meet all applicable NEC, NEMA and NESC requirements, along with any special Utility Company pole attachment requirements for the pole being attached.

For electrical service installations, the riser shall utilize a conduit, unless otherwise shown on the Plans.

For fiber optic installations, the riser shall utilize a U-Guard with backplate, unless otherwise shown on the Plans. The riser end attached to the wood pole shall be foam filled. The Contractor shall be responsible to calculate the minimum bend radius of the fiber optic cable and shall install the riser and fiber optic cable accordingly.

4. Installation of CommBox and Pull Box.

The Contractor shall install CommBoxes in the four steps specified in the Standard/Special Project details. A poured in place concrete collar shall also be installed around the CommBox in accordance with the Specifications when required by the Standard/Special Project Details and as shown on the Plans. This concrete collar shall be formed separately from any ITS concrete pole or structure foundations.

The Contractor shall install Pull Boxes as shown on the Plans.

The Contractor shall also install the Cable Rack for storing fiber optic cable maintenance coils and mounting splice closures within the CommBox and Pull Box as specified within this Specification and as shown on the Plans. The Contractor shall submit, for Engineer approval, the Cable Rack shop drawings/cut-sheets of the materials to be installed with the Material Submittal package.

No drilled holes shall be allowed in CommBoxes or Pull Boxes unless specified otherwise as shown on the Plans and accepted by the Engineer.

A grounding electrode (rod) shall be installed at CommBox and Pull Box locations where armored fiber sheaths for fiber optic cables and electrical service conductors are required to be grounded in accordance with the NEC and this Specification.

5. Installation of Fiber Marker Post.

Fiber Marker Post shall be installed according to the placement specified in the Standard/Special Project details. Fiber marker post shall be anchored with manufacturer's recommended anchoring system.

A "*proof check*" sample for the fiber marker post dome graphics, of quantity one, shall be produced and provided to the Engineer prior to procurement of the remaining units. The Contractor is required to obtain the Engineer's approval of the production fiber marker post including the dome cover label graphics prior to subsequent procurements by the Contractor. If the Contractor does not obtain approval prior to subsequent procurements, the Contractor assumes the risk of the fiber marker post being rejected even after installation. No payment shall be made to the Contractor if the fiber marker post is rejected.

Fiber marker post shall be placed no later than three days following the installation of the conduit that shall contain fiber optic cables. The Contractor shall be responsible for safeguarding the conduit and cables during the installation of the fiber marker posts. Any conduit or cables damaged during marker post installation shall be removed and replaced at the Contractor's expense.

6. Installation of Frequency Locate Marker.

Frequency Locate Markers shall be installed according to the placement specified in the Standard/Special Project details. Frequency Locate Markers shall be anchored with manufacturer's recommended anchoring system.

Frequency Locate Markers shall be placed no later than three days following the installation of the CommBox. The Contractor shall be responsible for safeguarding the conduit and cables during the installation of the Frequency Locate Markers. Any conduit or cables damaged during Frequency Locate Marker installation shall be removed and replaced at the Contractor's expense.

7. Installation of Surge-Protective Devices.

a. All conducting cables (i.e. communication, data, and power) entering the ITS Cabinet shall be surge protected as indicated on the Plans and in accordance with **Sub-Article 893.17(i), "*Surge Protection*"**.

b. Hub Buildings shall be surge protected as indicated on the Plans and in accordance with **Article 893.15, "*Hub Building*"** and **Sub-Article 893.17(i), "*Surge Protection*"**.

c. Electrical Power Service shall be surge protected as indicated on the Plans and in accordance with **Article 893.13, "*Electrical Power Service and Transformer*"** and **Sub-Article 893.17(i), "*Surge Protection*"**.

d. Dynamic Message Sign shall have surge protection in accordance with **Item 893.07(a)9, "*Transient Protection*"** and **Sub-Article 893.17(i), "*Surge Protection*"**.

(r) Testing.

1. Terminology.

Wherever the following terms are used in **Section 729** and **Section 893** the intent and meaning shall be interpreted as follows:

- *ITS Electronic Equipment* – Electronic equipment and/or devices paid for under **Article 729.04** and **Article 729.05**.
- *Interoperability* – The capability to operate devices from different manufacturers or different device types within the same communications system.

2. General.

Testing is a critical component of an ITS project. Not only does testing ensure the project was constructed as shown on the Plans and as specified within the Specifications, but it also validates the intent of the system. The following tests are conducted as part of each ITS project: Bench Testing, Field Testing, and Acceptance Testing.

The Contractor shall secure a test site for the Bench Test as shown on the Plans and as specified within this Specification. The test site must be submitted by the Contractor at the Pre-Construction meeting for approval by the Engineer. The Contractor shall provide the test location and facility, which shall be in the State of Alabama and within a twenty-five (25) mile radius of the project limits unless otherwise approved by the Engineer. If the Contractor fails to get test location approval prior to commencing any tests, the Contractor may be required to move testing to another site at the Contractor's expense.

There will be no direct payment to the Contractor for the cost of a suitable test site and for the setting up of the equipment for these tests. Testing should include all applicable items required to complete testing.

The Contractor shall notify the Engineer to schedule an Acceptance Test a minimum of seven (7) calendar days before each proposed test date. After successfully confirming attendance of all necessary personnel, the Engineer shall provide the approved test date to the Contractor and all attendees.

The Contractor shall perform tests in the presence of the Engineer. When problems arise during testing, the Engineer can require the Contractor to have a qualified technical representative on site during the specific testing. The Contractor shall arrange, at no additional expense to the Department, the attendance of the equipment manufacturer's qualified technical representative.

Testing shall be in accordance with ALDOT's Intelligent Transportation Systems Test Manual as developed by the Bureaus of Design and Maintenance; and, be documented with the corresponding ITS device's testing checklist(s).

If any ITS electronic equipment requires re-test, the above minimum test information shall be provided for each re-test per each piece of equipment.

Once a test is completed, a copy of the Test Result Documentation shall be submitted to the Engineer within seven (7) calendar days following completion of test activities. Any given test session is considered incomplete until the Engineer has approved the documentation for that test session.

It shall be the Contractor's responsibility for successful completion of each test. Any equipment which fails any tests shall be subject to re-test at no additional cost to the Department.

The Engineer's approval of test procedures, Test Result Documentation, and witnessing of such tests shall not relieve the Contractor of their responsibility to provide a completely acceptable and operating ITS project.

3. Bench Test.

The Contractor shall perform a Bench Test on all ITS electronic equipment and ITS Cabinets prior to installation. The Bench Test shall be performed by the Contractor at the approved test location and witnessed by the Engineer.

The Bench Test shall consist of the following two test phases:

a. The Visual Inspection phase shall consist of visually inspecting all Intelligent Transportation System (ITS) electronic equipment, ITS Cabinets and materials to insure there is no physical damage; and that the equipment and cabinets conform to their approved material submittal cut sheets.

b. The Manufacturer's Startup and Diagnostics test phase shall consist of the Contractor performing the manufacturer's out-of-the-box startup and diagnostic test for each piece of ITS electronic equipment, using the respective manufacturer's recommended startup diagnostics, configuration, and testing. The Contractor shall submit with the Material Submittal the manufacturer's recommended startup and diagnostic test procedures for review and approval prior to conducting the Bench Test.

The Contractor shall supply all temporary wiring and cabling (e.g. CAT-5/6/6A, RS-232/422/485, DVI, VGA, Coaxial, etc.), laptop, diagnostic software, and electrical service necessary for the Bench Test.

Test Result Documentation for the Bench Test, for each item in full contract quantity, shall be submitted to the Engineer for approval. The Engineer's approval shall be in writing.

The Contractor shall deliver all manufacturers' configuration and diagnostic software to the Engineer at the completion of the Burn-In.

4. Field Test.

The Field Test shall demonstrate that the ITS electronic equipment is properly operating, configured, and transmitting data to ALDOT's Intelligent Transportation Systems software applications as shown on the Plans and as specified within the Specifications. This test is conducted in the field at each ITS device site.

The Contractor shall not begin the Field Test until all ITS electronic equipment has successfully passed the Bench Test and its Test Result Documentation has been approved by the Engineer in writing.

The Contractor shall review the standard ALDOT Acceptance Test "*Functional Operations Test Procedures (FOTP)*" and submit any additional or modified items for review and acceptance to the Engineer. Any supplemental items to be added to the standard FOTP shall:

- identify the additional functional site and/or remote requirements to be tested;
- define the test procedure steps required for additional testing of these functional requirement(s); and,
- identify the expected results for successfully passing each additional test procedure.

The Contractor shall submit to the Engineer the standard Acceptance Test "FOTP" document or the amended FOTP such that a thirty (30) day review process may occur by the Engineer. No Field Test at any given site can begin until the Acceptance Test "FOTP" document has been accepted by the Engineer.

The Contractor shall supply all temporary wiring and cabling (e.g. CAT-5/6/6A, RS-232/422/485, DVI, VGA, coaxial, etc.), laptop, and diagnostic software necessary for the Field Test and performing the Functional Operations Test Procedures.

The Contractor shall not begin any Field Test until all work at that location is complete.

The Contractor shall perform a Field Test for each individual device at the site.

The Field Test shall consist of the following:

a. Visual Inspection.

The Visual Inspection shall consist of the Engineer visually inspecting all ITS electronic equipment, ITS Cabinets and materials to ensure that they were not damaged while being transported from the Bench Test location to the project site and being installed.

b. Field Demonstration.

The Installation shall consist of the Contractor demonstrating to the satisfaction of the Engineer the following minimum requirements:

- ITS electronic equipment, ITS Cabinets and associated materials have been installed as shown on the Plans;
- ITS electronic equipment has been properly connected (including the patch cables, fiber drop cable, and cable termination);
- Perform Continuity Test on supplied network, coaxial, DVI and VGA cabling; and,
- Inspect the installation of grounding and the surge protection systems (includes performing and successfully completing the Insulation Test, Continuity Test, and Ground Resistance Test as shown on the Plans and as specified within this Specification).

c. Performing Functional Operation Test Procedures (FOTP).

The Contractor and the Engineer shall perform the "*FOTP*" tests for each device installed at the site being tested. Results shall be documented on these "*FOTP*" test report forms.

The Contractor shall generate Test Result Documentation for the Field Test which shall be broken down by project site and include all ITS electronic equipment installed at each site. The complete package of the Test Result Documentation for the Field Test shall be submitted to the Engineer for acceptance. The Engineer's acceptance shall be in writing.

5. Acceptance Test.

The Acceptance Test shall demonstrate that the ITS electronic equipment installed in the field is properly communicating, operating and configured through ALDOT's Intelligent Transportation Systems software applications.

The Contractor shall not begin the Acceptance Test until all ITS electronic equipment has successfully passed the Field Test and its Test Result Documentation has been approved by the Engineer in writing. The Acceptance Test is typically conducted at the ALDOT TMC closest to the project location. However, the Engineer may approve a different location to conduct the Acceptance Test at his/her discretion.

Should any additional test procedure to the standard ALDOT Acceptance Test FOTP be deemed necessary for the Acceptance Test, the Contractor shall submit the additional test items following the same methodology as performed prior to the Field Test.

The Contractor shall perform an Acceptance Test for each individual site.

The Contractor shall not begin the Acceptance Test until all work at each site is complete and Field Test results accepted by the Engineer.

The Acceptance Test shall consist of performing the FOTP that were conducted as part of the Field Test.

The Contractor shall generate Test Result Documentation for the Acceptance Test. The Acceptance Test shall be submitted to the Engineer for acceptance. The Engineer's acceptance shall be in writing.

(s) Burn-In.

The Contractor shall perform Burn-In on the ITS electronic equipment, ITS Cabinets and materials to ensure their proper operation, interoperability and service for an extended time frame within actual field conditions and without any failures or maintenance problems.

The Contractor shall not begin the Burn-In until the Acceptance Test has been successfully completed for all sites and approved by the Engineer in writing.

After confirming all sites have successfully completed the Acceptance Test, the Engineer shall send written notice to the Contractor and all necessary personnel of the authorized Burn-In start date.

The Burn-In Period shall be thirty (30) consecutive calendar days without system failure. During the Burn-In Period, the Contractor shall expeditiously perform any necessary adjustment and replace any malfunctioning parts of the equipment required to place the system in an acceptable operational condition to the satisfaction of the Engineer. No extra compensation will be allowed for any work so required, such being considered incidental to furnishing and installing a complete operational system.

During the Burn-In Period, time charges shall be suspended if all other work has been completed and accepted pending the results of the Burn-In.

The Contractor shall deliver the As-Built Drawing package and all the ITS device manufacturers' Embedded Protocol Control software packages to the Engineer at the completion of the Burn-In.

The Burn-In Period is intended to be concurrent for all sites within the project. However, the Engineer may elect due to a state of emergency to allow multiple concurrent Burn-In periods to occur based on a breakdown of the project at his/her discretion (e.g., DMS sites, Camera sites, individual sites, etc.).

An equipment failure during the Burn-In Period is defined as a condition where a component stops functioning. A system failure is defined as a condition under which the system is unable to function as a whole or in significant part to provide the services as designated. While a single component failure may not constitute a system failure, chronic failure of that component or component type may be sufficient to be considered a system failure as determined by the Engineer. What constitutes a chronic failure shall be agreed upon in writing by the Contractor and the Engineer prior to beginning the Burn-In.

ITS electronic equipment which has repeated failures (repeated failures are defined as more than two in a thirty-day period) during the Burn-In Period shall be replaced by the Contractor at no cost to the Department. Field Test must be conducted for the new equipment and the Engineer's acceptance shall be obtained for said testing. Upon satisfactory completion of the testing, the Engineer will provide written authorization to commence with a thirty (30) day Burn-In Period for the new equipment.

Final acceptance shall mean successful completion of Burn-In to the satisfaction of the Engineer.

If any equipment or device fails to complete the thirty (30) day Burn-In Period, the Burn-In Period shall be suspended and time charges resumed. The Burn-In Period will not be restarted except when the following has been met:

- Repairs to the malfunctioning equipment/device have been satisfactory completed; and,
- The repaired equipment/device is to be re-tested and proven to be properly functioning.

Only upon the Engineer's acceptance of the repaired equipment/device, will the Contractor be allowed to resume the Burn-In Period.

General communication outage or failure due to hardware is considered a system failure in any case. Communication failure due to a minor component may not be a system failure. Specifically exempted as system failures are failures caused by accident, natural disasters, or other external forces. The Engineer will advise the Contractor in writing when it considers that a system failure has occurred or a chronic failure exists.

Each system failure during this Burn-In Period shall require restarting the clock plus an additional two (2) calendar days of successful operation prior to being eligible for final acceptance (i.e., if there are two system failures during the initial 30 day period, the period would be increased by 4 days). Successful completion of the Burn-In Period shall occur at the end of thirty (30) complete calendar days of operation without a system failure ascribable to hardware, software, or communications components.

The Contractor shall generate Test Result Documentation for the Burn-In which shall include at a minimum:

- Documentation for any ITS electronic equipment failures, system failures or communications failures;
- Document corrective actions taken by the Contractor for equipment repairs;
- Any re-test documentation for the repaired or replacement equipment;
- All manufacturers' ITS electronic equipment protocol control software; and,
- All manufacturers' configuration and diagnostic software along with licenses transferred to the Department.

This Test Result Documentation shall also consist of the minimum applicable information as specified within Acceptance Test of the Specification. Once the Burn-In Period is successfully completed, the Contractor shall submit the complete package of the Test Result Documentation for Burn-In to the Engineer for acceptance. The Engineer's acceptance shall be in writing, which acknowledges receipt of the Test Result Documentation along with verification that Burn-In was successfully completed.

If equipment or device failures occur, the Engineer may request for the Contractor to submit advance copies of the Burn-In Test Result Documentation so as to gain insight to the equipment problems and any corrective actions taken to date.

(t) Training.

The Contractor shall provide installation, operations and maintenance training for up to ten (10) people. Training shall be performed by product manufacturer(s) for the ITS electronic equipment installed on the Project; and shall be performed both in the field and in the office (or classroom). Training shall include all applicable items required to complete training.

The Contractor shall notify the Engineer to schedule training a minimum of seven (7) calendar days before the proposed training date. After successfully confirming attendance of all necessary personnel, the Engineer shall provide the accepted training date to the Contractor and all attendees. The Contractor shall be responsible for coordinating accepted training date with the product manufacturer instructor(s), along with any field and in-office preparations for completing this training. The Contractor shall take into consideration any time necessary for product manufacturer's instructor(s) travel (including lead times for booking flights and/or rental cars, time for actual commutes, and time for any field or classroom setup).

The Contractor shall include in the cost of training all supplies, equipment, materials, user manuals, handouts, travel, and subsistence necessary to conduct the training. A training notebook shall be provided to each trainee in a labeled 3-ring binder.

The Contractor shall submit the proposed training package to the Engineer for acceptance. The training package shall include detailed course curriculum(s), detailed daily training schedule, draft manuals, handouts, and resumes of all instructors. This training package shall be submitted a minimum of thirty (30) calendar days prior to scheduling training. The Engineer shall review the proposed training materials and reserves the right to request modifications to the training program and materials as appropriate. The Engineer's acceptance of the training package shall be in writing.

Training shall not last for more than eight (8) hours of any given day (i.e., twenty-four (24) hours of training would be conducted over at least a three (3) day period). Training shall be a mixture of formal classroom and hands-on training, and at least half of the training shall be hands-on. Training shall be conducted at a facility approved by the Engineer and shall be completed within sixty (60) days after completion of Burn-In. Upon the request of the Contractor, the Engineer may approve training to be conducted prior to completion of Burn-In.

The training shall be for the ITS electronic equipment as shown on the Plans or as specified within the Specifications; and, for any modifications or enhancements made by the Contractor to ALDOT's Intelligent Transportation Systems software applications or overall ITS system.

Training material shall serve not only as training course guidance, but also as a quick reference guide for future use by the attendee. A copy of all training material, in reproducible form, shall be delivered to the Engineer after training is complete.

(u) Warranty.

The Contractor shall warrant and guarantee the satisfactory in-service operation of all ITS equipment and all related apparatus, specified or implied within the Specifications and as shown on the Plans, for a warranty period of one (1) year following the completion of partial acceptance for maintenance. The Contractor's warranty shall be a written guarantee that the ITS equipment will be fully functional and will remain free of defects in material and workmanship during said warranty period.

Upon successful completion of a required Burn-In Period, the Contractor may request partial acceptance for maintenance, as addressed by **Sub-Article 105.15(b)**, of the portion or component of the work covered by the Burn-In. The Engineer will review the request and will issue partial acceptance for maintenance if the installation has been acceptably completed. The warranty period will then start for that portion or component of the work.

During the warranty period, the Contractor shall repair with new materials, or replace at no charge, any device, product, or other material containing a warranty defect. During the support period, the Contractor shall enter a precise description of any necessary repair work performed into a logbook. All materials returned from warranty repairs shall be made through the distributor or manufacturer at no additional charge. Warranty repairs and replacements shall be completed within two weeks from date of return to the distributor or manufacturer.

Before final payment is made, the Contractor shall supply ALDOT's Construction Bureau a letter setting forth the dates of the guarantees giving a telephone number, an address, and a person to contact for any required warranty service.

The Contractor shall transfer any available manufacturer's warranties or guarantees to the Department. These warranties and guarantees shall be continuous throughout their duration and state that they are subject to such transfer.

The Department will not make the final payment for work under this Section until the warranties, guaranties and contact information are furnished to the Engineer.

729.04 Method of Measurement.

The Intelligent Transportation Systems shall be measured for payment by the appropriate items complete, in place, acceptably installed, tested and operational in accordance with the following:

ITEM 729-A: Fiber Optic Cable with number of fibers indicated shall be measured per linear foot.
ITEM 729-B: Fiber Distribution Unit, Fan-Out Kit, and Fiber Optic Patch Cable shall be measured by each unit installed.
ITEM 729-C: Network Device shall be measured by each unit installed.
ITEM 729-D: Camera shall be measured by each unit installed.
ITEM 729-E: Vehicle Detection Systems shall be measured per each device installed.
ITEM 729-F: Dynamic Message Sign shall be measured by each unit installed.
ITEM 729-G: Environmental Sensor shall be measured by each unit installed.
ITEM 729-H: Highway Advisory Radio shall be measured by each unit installed.
ITEM 729-I: Conduit, Conductor, Locate Tone Wire, Messenger, and Warning Tape shall be measured per linear foot.
ITEM 729-J: ITS Cabinet shall be measured by each unit installed.
ITEM 729-K: Electrical Power Service and Transformer shall be measured per each site/unit installed.
ITEM 729-L: Pole shall be measured by each unit installed.
ITEM 729-M: Building shall be measured per lump sum.
ITEM 729-N: Miscellaneous Infrastructure shall be measured by each unit installed.

729.05 Basis of Payment.

Unless otherwise indicated below, all payments shall be made in increments of:

1. Up to 70% of the contract unit price upon successful completion of the BENCH TEST and installation of item(s) [Partial payments may be made in accordance with **Article 109.07** up to this percentage.];
2. Additional 15% of the contract unit price upon completion of the FIELD TEST; and,
3. Final 15% of the contract unit price upon completion of the ACCEPTANCE TEST (BURN-IN).

(a) Unit Price Coverage.

ITEM 729-A. FIBER OPTIC CABLE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following: fiber optic cable with the number of fibers indicated; attached to messenger wire and pulled through conduit when required; all required connections; fiber optic cable tags and labeling; aerial slack brackets; manufacturer and Contractor warranties; and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work. (*Please Note*: Conduit, Messenger Wire, Fiber Marker Post, and Fusion Splicing are separate pay items.)

ITEM 729-B. FIBER DISTRIBUTION UNIT, FAN-OUT KIT, FIBER OPTIC PATCH CABLE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Fiber Distribution Unit: including housing, panels, connectors, connector barrels, zip ties, clamps, cable trays, cable management organization, and labels; all adapters/couplings, for the number of fibers indicated, all required termination splicing; mounting brackets and hardware;
b. Fan-Out Kit: fan-out kit with adapters/couplings, for the number of fibers indicated;
c. Fiber Optic Patch Cable: fiber optic patch cable of functional length required to connect the associated equipment and FDUs; connectors, connector barrels, and associated hardware;
d. manufacturer and Contractor warranties;
e. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

Fan-Out Kit and Fiber Optic Patch Cable will be paid at 100% of the contract bid price upon completion of the installation of these items.

ITEM 729-C. NETWORK DEVICE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Network device with all necessary electrical components, including but not limited to wiring, cabling, harnesses, and indicators;
b. Wireless Licensing (including wireless path loss analysis and testing, frequency coordination, FCC application process, and associated costs/fees);
c. Network hook-up, fiber optic transceivers field and head-end, wireless communication devices (antenna, dishes, remote and head-end), communication modules with data cables (CAT 5E/6/6A patch cables, antenna cables and mounts);
d. Equipment mounts;
e. Power hook-up; power supplies with power cables;
f. Surge protection for communication/data and power; grounding system;
g. Manufacturer's operational software package(s) and firmware;
h. Initial configuration, Acceptance Testing with Burn-In, complete device documentation, manufacturer and Contractor warranties and support;
i. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-D. CAMERA, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Camera assembly complete with all components including, but not limited to: camera, lens, pan/tilt drive, control electronics and environmental enclosure, cables (power, video and control), housing assembly and mounting brackets;
b. camera/video drivers, control and diagnostics software, initial configuration; complete camera documentation/manuals;
c. Network connection and configuration;
d. Surge protection for communication/data and power;
e. Power supplies with cabling and connection;
f. Grounding system; air terminals and lightning protection system;
g. Testing (including all test report/packages, electronic files and deliverables), Training (including all instructors, travel, classroom and field materials, electronic files and deliverables), and Acceptance Testing with Burn-In;
h. Manufacturer and Contractor warranties and support;
i. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-E. VEHICLE DETECTION SYSTEMS, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Vehicle Detection Systems complete with all components including, but not limited to: vehicle detection unit(s) (e.g. sensors, repeaters, access points, antenna), control and interface equipment (e.g. detection system processor, communication interface panel, cabinet interface unit), cables (power, data and control), housing assembly, and mounting brackets (with pole extensions if required);
b. Vehicle Detection device/equipment drivers, control and diagnostics software, initial and post configuration (e.g. software setup and programming, adjusting detection zones, adjustment for repeaters and access points); license(s); complete Vehicle Detection Systems documentation/manuals;
c. Network connection and configuration;
d. Surge protection for communication/data and power;
e. Power supplies with cabling and connection;
f. Grounding system; air terminals and lightning protection system (if required);

g. Testing (including all test report/packages, electronic files and deliverables), Training (including all instructors, travel, classroom and field materials, electronic files and deliverables), and Acceptance Testing with Burn-In;
h. Manufacturer and Contractor warranties and support;
i. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-F. DYNAMIC MESSAGE SIGN, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. All electrical, electronic, or electromagnetic components use in any DMS assembly, including but not limited to capacitors, potentiometers, resistors, semiconductor devices, transformers, inductors, circuit breakers, switches, terminal blocks, wiring, cabling, harnesses, indicators, electromechanical shutter units, light emitting diodes and modules, lamps, driver boards, sign control logic boards, opto-isolation cards, photosensors, sign electronics power supply, pin and socket connectors, PCB connectors, wire connectors, PCB assemblies, fans, filters, and warning beacons;
b. All DMS housing components including, but not limited to: the walk-in housing assembly and mounting hardware, DMS platform and housing door, and maintenance safety eyebolts;
c. DMS controller and remote controller, if any;
d. Network connection and configuration;
e. Power supplies with cabling and connection;
f. Surge protection for communication/data and power;
g. Grounding system; air terminals and lightning protection system;
h. Software/driver interfaces, control and diagnostics software, initial configuration; complete DMS documentation;
i. Testing (including all test report/packages, electronic files and deliverables), Training (including all instructors, travel, classroom and field materials, electronic files and deliverables), and Acceptance Testing with Burn-In;
j. Manufacturer and Contractor warranties and support;
k. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-G. ENVIRONMENTAL SENSOR, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Environmental Sensor system including, but not limited to: air temperature sensor, relative humidity sensor, visibility sensor, precipitation rate sensor, barometric pressure sensor, wind speed and direction sensor, pavement precipitation depth sensor, and either an in-road or remote road pavement sensor, as shown on the Plans;
b. Environmental Sensor data processing unit and remote controller, if any;
c. All Environmental Sensor housing components including, but not limited to: the housing assembly, and mounting brackets (with pole extensions if required) and hardware;
d. Environmental Sensor device/equipment drivers, control and diagnostics software, initial and post configuration (e.g. software setup and programming, adjusting sensors); license(s); complete Environmental Sensor(s) documentation/manuals;
e. All wiring, cabling, harnesses and connections; Network connection and configuration;
f. Surge protection for communication/data and power;
g. Power supplies with cabling and connection;
h. Grounding system; air terminals and lightning protection system (if required);
i. Testing (including all test report/packages, electronic files and deliverables), Training (including all instructors, travel, classroom and field materials, electronic files and deliverables), and Acceptance Testing with Burn-In;
j. Manufacturer and Contractor warranties and support;
k. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-H. HIGHWAY ADVISORY RADIO, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Highway Advisory Radio complete with all components including, but not limited to: radio transmitter, digital recorder/player, GPS synchronizer, HAR enclosure/cabinet, antenna subsystem, and mounting hardware;

b. HAR local and remote controller, if any;
c. Highway Advisory Radio device drivers/interfaces, HAR system software (including control and diagnostics software), initial configuration; FCC license(s); complete HAR documentation/manuals;
d. All wiring, cabling, harnesses and connections; Network connection and configuration;
e. Surge protection for communication/data and power;
f. Power supplies with cabling and connection;
g. Grounding system; air terminals and lightning protection system (if required);
h. Testing (including all test report/packages, electronic files and deliverables), Training (including all instructors, travel, classroom and field materials, electronic files and deliverables), and Acceptance Testing with Burn-In;
i. Manufacturer and Contractor warranties and support;
j. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-I. CONDUIT, CONDUCTOR, LOCATE TONE WIRE, MESSENGER, and WARNING TAPE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Conduit: including pull tape, ~~locate tone wire (when fiber optic cable is to be installed in conduit)~~, conduit hangers, brackets, coupling, conduit lubricant, accessories, supports, attachment hardware, hardware, fittings, trenching, placing, joining, attaching to structure, backfilling, seeding and mulching of disturbed areas, disposal of debris;
b. Conductor or Locate Tone Wire: including hardware, fittings, trenching, placing, joining, attaching to structure, backfilling, seeding and mulching of disturbed areas, disposal of debris;
c. Messenger: messenger wire, lashing, down guy, mounting brackets, supports, accessories, insulators, hardware and fittings, couplings, grounding electrode system;
d. Warning Tape: including print proofs, tape splicing components, trenching, placing, backfilling, seeding and mulching of disturbed areas, disposal of debris;

e. Friction Reduction Multiduct Sleeve: sleeve material and pull tape;
f. Manufacturer and Contractor warranties; and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-I will be paid at 100% of the contract bid price upon installation.

ITEM 729-J. ITS CABINET, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Cabinet complete with documentation, base mount foundation, pole mount attachment hardware, incidental hardware;

b. Fully mounted, either pole, base, or pedestal, as shown on the Plans with all required conduits.
c. Electrical wiring, transformers, breakers, fans, switches, interior lighting, terminal blocks, receptacles, panel board, surge protection, cable racks, equipment bays, other devices as indicated, and all associated incidental equipment inside the cabinet;
d. Grounding electrode system;
e. Manufacturer and Contractor warranties and support;
f. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-K. ELECTRICAL POWER SERVICE and TRANSFORMER, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Electrical Power Service: including enclosure, circuit breaker(s), disconnect switch(es), transient/surge protection, weather head, vertical conduit(s) and riser; meter base installation (as required by the utility);
b. Transformer: including enclosure, disconnect switch(es), transient/surge protection, step-up/step-down transformer(s), vertical conduit(s) and riser;
c. All wiring from utility service to the meter base and connections (*Please Note*: Lateral/horizontal conductors, after the service disconnect/meter base, are separate pay items.);
d. Wood pole(s), guy wire, excavating, backfilling, attachment hardware, grounding system, and attachment to local utility;
e. Manufacturer and Contractor warranties;
f. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-L. POLE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing and installing, complete in place, as shown on the Plans, with the following:

a. Complete Pole assembly with all components including, but not limited to: pole, tenon (if required), foundation (if required, with reinforcing steel, rebar, anchor bolts, conduits, auger and base plate), design calculations, weather head(s), vertical conduit and riser;
b. Guy wire (if required),
c. Drilling, excavation and backfill, attachment hardware;
d. Grounding system; air terminals and lightning protection system (if required);
e. Manufacturer and Contractor warranties;
f. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-L will be paid at 100% of the contract bid price upon completion of the installation of the pole.

ITEM 729-M. BUILDING, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Hub Building complete with all interior lighting, receptacles, switches, panel board, wiring/conductors/conduits, surge protection, grounding system, security system, cable racks, generator (with concrete pad), automatic transfer switch, and other devices as indicated;
b. Installed complete on a foundation with all utilities connected and operational, incidental hardware, and gas source for the generator, at no separate cost to the Department;
c. Manufacturer and Contractor warranties and support;
d. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 729-N. MISCELLANEOUS INFRASTRUCTURE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. Fusion Splicing: fusion splices, fusion heat shrink sleeves and incidentals, testing, and documentation (All splices and terminations shall be accurately and fully documented on forms supplied by the Department. No payment for splices or terminations shall be made unless forms have been accurately completed by the Contractor and approved by the Engineer.);
b. Splice Closure: splice closure housing with seals, splice organizer, splice trays, mounting brackets, hardware, and accessories;
c. Riser Assembly: riser, backplate, conduit, couplings, weatherhead, standoffs, mounting brackets, supports, hardware, and accessories;

d. CommBox: communication box with cover, cable rack system, attachment hardware, base material, and concrete collar; grounding electrode system (where required); excavation, backfilling, seeding and mulching of disturbed areas; disposal of debris;
e. Pull Box: pull box with cover, cable rack system, cable management, attachment hardware, supports, and all necessary accessories; grounding electrode system (where required);
f. Fiber Marker Post: post, dome with graphics label and sleeve, and anchor;
g. Frequency Locate Marker: locate marker unit and labeling;
h. Uninterrupted Power Supply: control/monitoring unit, batteries, transient/surge protection, wiring, network card, mounting, and incidental hardware and software;
i. Manufacturer and Contractor warranties; and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

Fusion Splicing, Splice Closure, Riser Assembly, CommBox, Pull Box, Fiber Marker Post and Frequency Locate Marker will be paid at 100% of the contract bid price upon completion of the installation of these items.

(b) Payment will be made under Item No.:

729-A Fiber Optic (1) Cable, ____ - per linear foot
729-B Fiber Distribution Unit, (2) - per each
Fan-Out Kit – per each
FO Patch Cable, (3) - per each
729-C Network Device, (4) - per each
729-D Camera, (5) - per each
729-E Vehicle Detection System (6) - per each
729-F Dynamic Message Sign, (7) (8) - per each
729-G Environmental Sensor, ____ - per each
729-H Highway Advisory Radio, (9) - per each
729-I Conduit, (10) - per linear foot
Conductor, (11) - per linear foot
Locate Tone Wire - per linear foot
Messenger - per linear foot
Warning Tape - per linear foot
729-J ITS Cabinet, Type ____ - per each
729-K Electrical Power Service (12) - per each
Transformer (13) – per each
729-L Pole, (14) - per each
729-M Building, (15) - per lump sum
729-N Miscellaneous Infrastructure, ____ - per each

(1) Specify Cable Type [Trunk, Drop, or Armored]
(2) Specify Fiber Distribution Unit Type [Primary or Secondary]
(3) Specify FO Patch Cable Type and Length
(4) Specify Network Device Type
(5) Specify Camera Type [Fixed, Positioner, or Dome]
(6) Specify Detection Type [Radar, Magnetometer, or Bluetooth]
(7) Specify Dynamic Message Sign Type [Walk-In, Front Access, or Dedicated]
(8) Specify Dynamic Message Sign Size
(9) Specify Highway Advisory Radio Type [Permanent or Portable]
(10) Specify Conduit Type [Exposed, Underground, Rigid Metallic, Reinforced Thermosetting Resin, or Friction Reduction Multiduct Sleeves] and Size [1 1/2", …, 2 x 2 Inch]
(11) Specify Conductor Size [8 AWG, 6 AWG, 4 AWG, 2 AWG, 1 AWG, 1/0 AWG, 2/0 AWG, 3/0 AWG, 4/0 AWG, 250 KCMIL, 400 KCMIL, or 500 KCMIL]
(12) Specify site location
(13) Specify Transformer Type and/or Size
(14) Specify Pole Type [Concrete, Steel or Fiberglass]
(15) Specify Building Type and/or Site location

SECTION 730
TRAFFIC SIGNALS

730.01 Description.

This Section shall cover the work of furnishing and installing of traffic signal control equipment. These requirements may be supplemented or amended by the requirements given elsewhere in the specifications, or on the plans and Special and Standard Highway Drawings.

Descriptions and definitions of the equipment, words and terminology used in the furnishing and installing of traffic signal control equipment are given in the Manual of Uniform Traffic Control Devices (MUTCD) publications of the Institute of Transportation Engineers (ITE), the National Electrical Manufactures Association (NEMA), the National Electrical Code (NEC), and the International Municipal Signal Association (IMSA).

730.02 Materials.

All materials furnished for use shall conform to the requirements given in Section 890, shown on the plans, or listed in the ALDOT "Materials, Sources, and Devices with Special Acceptance Requirements Manual" (MSDSAR). All furnished materials and equipment shall be new and free from defects. Existing equipment shall only be used if shown on the plans to be re-used.

730.03 Construction.

(a) Design and Construction Codes and Coordination of the Work.

1. Codes.

   All installations shall comply with the regulations of the latest edition of the National Electrical Code and the latest edition of the National Electrical Safety Code, and with the service rules of the Utility Company providing the electricity.

2. Structure Design and Construction.

   Structures for the support of traffic signal control equipment shall be designed, furnished, and installed in accordance with the requirements given in Sections 718 and 891.

3. Coordination of the Work.

   Coordination of the work with roadway and bridge work will be of prime importance to prevent undue damage to completed items of work and existing facilities. Any damage to existing facilities caused by the installation of the material or equipment required under this Section shall be repaired by the Contractor at no additional cost to the Department.

4. Electrical Power.

   The entity that will be responsible for the eventual operation and maintenance of the traffic signal unit and intersection lighting will make application for electrical service upon notification that power service will be required. The Contractor shall inform the Engineer when power service is required at least 30 calendar days prior to the need of the power service. This same entity will be responsible for the cost of the service connection and the monthly service billings thereafter. Power shall be single phase, 240 Volt, provided through a transformer that is not tapped to provide power to any other equipment.

(b) Traffic Signal Technician.

Technician(s) responsible for the performance of the work shall be certified by the IMSA as an IMSA Traffic Signal Level II Field Technician. The Contractor shall submit a copy of the IMSA certification to the Engineer with the first Material Submittal that is submitted for approval. The technician(s) shall be in possession of the certification at all times and show this certification as often as asked by the Engineer.

Certified Traffic Signal Technicians shall be present and shall have direct involvement with all work required for the installation and operational testing of electrical materials and equipment (conduit, boxes, conductors, etc.). At least one out of every three persons in a crew shall be a certified IMSA Traffic Signal Level II Field Technician.

(c) Drawings and Specifications.

Omissions from the plans and specifications or errors in the details of work which are evidently necessary to carry out the intent of the plans and specifications or which are customarily performed, shall not relieve the Contractor from performing such omissions and details of work. In any case of

discrepancy in descriptions on the plans or in these Specifications, the matter shall be promptly submitted to the Engineer, who will make a determination in writing. Any adjustments in the plans, details, specifications, and proposal by the Contractor without written permission of the Engineer shall be at the Contractor's own risk and expense.

(d) Material and Equipment Lists, Shop Drawing and Approval.

Material and equipment listings shall be submitted to the Design Bureau's Traffic Design Section for approval within 30 days after the issuance of the "Notice to Proceed". Partial listings and shop drawings will not be accepted for consideration and shall be returned for correction without review.

Five copies of each submittal shall be furnished for review. Material and equipment lists shall include catalog cutouts or published data sheets and shall be completed on the Department's Material Submittal Form The submittal form shall have each item sequentially numbered, a reference to the Specification Section and/or plan sheet, and a description of the material. The description shall include the type, model number, catalog number, and manufacturer, and shall include a legible manufacturer's catalog cut sheet with each item being submitted clearly identified. All individual components of assembled equipment (cabinets, controllers, etc.) shall be itemized on the submittal form. Submittals shall be clear and complete. Pay Items are not to be referenced on the form.

Unacceptable items on the submittal form will be returned for corrective action. A copy of the approved material and equipment listings will be returned to the Contractor.

Any changes to the approved material and equipment lists must be requested in writing through proper channels.

If requested by the Engineer, the Contractor shall submit for inspection and approval samples of both the specified and proposed substitute items at no cost to the Department. The Department will not be liable for any materials purchased or work done or any delay incurred before such approval. Failure of the Engineer to note unsatisfactory material as received will not relieve the Contractor from responsibility. Manufacturers' warranties and guaranties furnished on equipment used in the work shall be delivered to the Engineer; likewise, instruction sheets and parts lists shall be delivered to the Engineer upon receipt of the equipment.

Throughout the entire project, the same manufacturer shall make all units of any one item, such as poles, signal heads, detectors, controllers, cabinets, etc.

Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of material and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Whenever any article, material, or equipment is defined by using the name of a manufacturer or vendor, the term "or approved equal" if not inserted, shall be implied.

(e) Approved Traffic Control Devices and Materials.

Some materials and equipment required to be furnished under this Section will be standard production type products. Acceptance will be made by the Engineer based on selected confirmation tests, the manufacturer's certification of the materials and equipment, and visual inspection at the job site. The manufacturer shall make available to the Department test data and material samples from the production runs for use in evaluation of these items. Title 32, Chapter 5A, Subsection 36 of the Code of Alabama states that all traffic control devices shall be approved by the Transportation Director before they can be used, sold, or offered for sale. Approved devices are shown on the Department's MSDSAR.

(f) As-Built Drawings.

After all equipment has been installed and the operational check has been initiated, the Contractor shall submit a set of plans showing in detail all changes on construction from the original plan details with special notation given to conduit location and elevation and schematic circuit diagrams.

(g) Operational Manuals.

Operation manuals and as-built wiring diagrams shall be furnished for all equipment and accessories required in the controller cabinet. These manuals and wiring diagrams shall be mounted to the cabinet in an appropriate manner. In addition, two copies of these manuals and wiring diagrams shall be transmitted to the Department's Area Traffic Engineer.

(h) Pre-Installation Test (Bench Test).

Before the installation of the traffic control system(s) or unit(s), the Contractor shall perform an equipment bench test. This test shall include all controllers, monitors, and other cabinet equipment as required under signal load conditions for a minimum of seven consecutive days.

The Contractor shall secure an acceptable site, approved by the Engineer, for the bench test and shall perform all work required in the performance of the test. The Contractor shall notify the Engineer of the date that the test is to begin a minimum of seven days before that date. The Engineer will schedule an inspection of the equipment with the Area Maintenance Engineer in coordination with the State Signal Shop. The bench test shall not begin until the Area Maintenance Engineer has given approval after the State Signal Shop has verified and inspected the equipment to be used.

None of the equipment shall be installed on the project until the bench test has been completed and the Contractor has submitted a letter to the Engineer certifying that the equipment performed satisfactorily during the test. Any equipment failure during this time shall be corrected, and the bench test time shall be restarted. There will be no direct payment to the Contractor for the cost of the pre-installation test including the cost of a suitable test site and the setting up of equipment for the test.

(i) Removal of Equipment.

All equipment designated or directed to be removed shall be removed in such a manner that the removed equipment will not be damaged. Any damage due to negligence on the part of the Contractor because of lack of proper care of equipment shall be cause for the Engineer to order its replacement. The cost of replacement shall be borne fully by the Contractor. Any equipment or materials not authorized by the Engineer for re-use into a new facility shall be stored by the Contractor until the Engineer directs that they be delivered by the Contractor to the Department at the time and location designated by the Engineer. Storage facilities shall be provided so that the equipment will be protected from the elements and damage by vandalism.

(j) Concrete Foundations.

The Engineer will inform the Contractor of the exact diameter and depth of concrete foundation required at each signal pole foundation. The Engineer will also inform the Contractor of any changes that are required to the size and number of reinforcing bars required at each signal pole foundation. This information will be given to the Contractor at the completion of the review of the Contractor's submittal of designs and details of the signal pole structures.

All conduit systems, elbows, etc., shall be installed securely and inspected by the Project Manager before concrete is poured.

The Contractor shall contact the utility companies to determine the location of underground utilities in the area where the foundations are to be located and shall be responsible for repairing, to the satisfaction of the utility company, any damaged utilities.

(k) Abandoning Foundations.

All foundations, when abandoned, the top of the foundation, anchor bolts frame and conduit shall be removed to a depth of not less than 12 inches {300 mm} or as directed below the surface of existing pavement. The resulting hole shall be backfilled with material to match the existing surface.

(l) Interconnect Cable.

1. General.

Interconnect cable wire shall be installed at locations as shown on the plans or as directed by the Engineer.

Splices shall be made only where shown on the plans or in the controller cabinet.

A minimum of 6 feet {1.8 m} or as directed, of slack shall be provided at each cabinet.

2. Underground Interconnect Cable.

Underground interconnect cable shall be run in conduit.

3. Aerial Interconnect Cable.

Aerial interconnect cable shall be supported on new or existing utility poles and/or signal poles as shown on the plans.

Interconnect support cable wire supporting signal control cable only will be sagged to a vertical distance not greater than 2 percent of the length of the span between poles.

When support cable is not an integral part of the interconnect cable, interconnect cable shall be attached to a support wire.

(m) Electrical Power Service Assembly.

The location of the utility service point and power source shown on the Signalization Plans is approximate. The Contractor shall determine the exact location.

When the service equipment is to be installed on a utility-owned pole, the Contractor shall furnish and install conduit, photoelectric control unit, conductors, and other necessary material to complete the installation of the service. The position of the riser and equipment will be determined by the utility.

When a lateral drop is required from the power source to the service pole, the Contractor shall arrange with the serving utility to complete the service connections. The Contractor shall install the conduit, conductors, enclosure and accessories, and service pole.

As a minimum, the electrical power service equipment shall consist of:

- A weatherhead;
- 1 inch {27 mm} metallic conduit from weatherhead to a disconnect switch;
- A disconnect switch installed 6 feet {2 m} high, including, but not limited to the enclosure, load center complete with circuit breaker in a nema type 4 enclosure, masterlock size #3, key #3210 (for statewide uniform access);
- 1 inch {27 mm} metallic conduit from disconnect switch to a designated depth below the ground line;
- Attachment hardware;
- Ground rod and related equipment;
- Service cables;
- No. 8 awg service cable for any required luminaires;
- Attachment to local utility;
- All incidentals required to provide power service to the controller assembly and luminaires.

(n) Span Wire.

The installation of span wire shall meet all provisions of the National Electric Safety Code (ANSI-C2) regarding clearance from electric lines.

The length of the messenger wire shall be adjusted under the load of traffic control equipment so that the sag at the lowest point shall not be greater than the requirements in Section 718.

(o) Vehicular and Pedestrian Signal Heads.

Vehicular or pedestrian signal heads shall not be installed until all other signal equipment, including the controller, is in place and ready for operation except that signal heads may be installed if no face of the head is directed toward traffic or if the entire assembly is hooded.

Each signal face shall be so adjusted vertically and horizontally in order that its beams will be of maximum effectiveness to the approaching traffic for which it is intended.

All required vehicular signal heads shall include a backplate with a 2 inch{5 cm} fluorescent yellow border unless otherwise directed by the Engineer or shown on the plans.

(p) Traffic Detection Systems.

1. Inductive Loop.

a. Installation of Loop Wire.

Before cutting required loops into the pavement, any existing loops that are not quadrupole loops shall be sawed in two locations and quadrupole loops shall be sawed in three locations on the long side to prevent false readings when the required loops are placed into the pavement. Loop wire outside the sawcut shall be twisted 3 turns per foot.

Loop wire shall be one continuous run without splices.

Loop wire shall be pushed to the bottom of the saw cut with a non-metallic tool that will not damage the insulation.

Each loop wire shall be placed in its own individual sawcut to the edge of pavement.

No portion of the loop shall be located within 3 feet {1 m} of any conductive material in the pavement such as manhole covers, water valves, and grates, etc.

After installation of the loops, the slots shall be sealed with an approved sealant manufactured specifically for embedding loop detector wire in concrete or bituminous pavements.

All loop connectors shall be connected to a shielded home-run cable located in junction box or when so directed or shown on plans at base of traffic signal strain pole.

Preformed loops that are listed on the MSDSAR may be used.

b. Sawcuts for Loops.

Slots for installing the loops shall be formed by sawing with approved equipment designed for sawing pavement, to the width and depth indicated by the plan details or directed.

The slot shall be cleaned of all foreign loose debris using compressed air or other approved means before installation of the loop wires.

Sawcut corners shall be cut at a diagonal. No sharp bends shall be accepted.

Loops shall be tested prior to sealing sawcuts. Loop sealant shall be placed in sawcuts in accordance with manufacturer's recommendations.

Loop sealant will not be permitted when there is moisture on the surface, the air temperature is below 40 °F {4.4 °C}, or other conditions exist that in the opinion of the Engineer would affect the bonding of the material.

c. Loop Detector Lead-In.

A separate run of shielded home-run cable shall be provided for each loop unless otherwise directed by the Engineer.

Lead-in cable installed underground shall be in conduit. The lead-in shall be one continuous run from controller to loop connection with no splices.

d. Testing Loops.

The Contractor shall perform a leakage to ground test on all loops using a MEG-OHM meter with 500 V applied. The loops shall also be tested after the lead-ins are pulled to the amplifier to detect any damage done during installation. A State Inspector will perform this same test to check for leakage. Any loop failing to read 100 MEGS or better shall be replaced by the Contractor at no additional cost to the project.

2. Video Detection System (VDS).

The Contractor shall furnish and install all equipment, materials, software and other miscellaneous items that are required to provide a fully functional Video Detection System for the control of vehicular and pedestrian traffic signals.

The Contractor shall establish the configuration of the required traffic detection zones within each controller cabinet up to a maximum of 26 detection zones per controller. The Contractor shall notify the Engineer prior to software configuration and detector zone setup in ample time to allow the Engineer to observe this work. There will be no additional payment made for the relocation of cameras that may be required to achieve the required configuration.

The VDS shall detect the presence of a vehicle in the zones with at least 95 % accuracy at any time during the day.

The Contractor shall have a qualified representative of the supplier of the VDS to be present at the site of the installation to verify that all equipment and materials are being installed correctly. The representative of the VDS supplier shall be available to address all issues of concern that the Engineer may have.

All coaxial cable and power cable shall be one continuous pull without splices between the camera mounting location and the traffic controller cabinet.

3. Radar Detection System.

The Contractor shall establish the configuration of the required traffic detection zones within each controller cabinet. The Contractor shall notify the Engineer prior to software configuration and detector zone setup in ample time to allow the Engineer to observe this work. There will be no additional payment made for the relocation of the microwave sensors that may be required to achieve the required configuration.

All communication, data, and power cabling shall be one continuous pull without splices between the radar mounting location and the traffic controller cabinet or wireless relay point.

4. Magnetometer Detection System.

The Contractor shall install the required traffic sensors in the roadway to produce the required vehicular detection for each location/zone. Sensors that communicate via a hard-wire connection shall be spliced in the junction box using an approved, water tight splice kit to the home-run cable, without splices, back to the cabinet. For wireless sensors, the Contractor shall verify the communication of the sensors to the system to ensure the sensors are set-up properly before connecting the system to the controller. The Contractor shall notify the Engineer prior to software configuration and detector setup in ample time to allow the Engineer to observe this work. There will be no additional payment made for the relocation or addition of sensors that may be required to achieve the required detection.

5. Pedestrian Push-Button System.

The Contractor shall install the required pedestrian push-buttons in accordance with the locations shown on the plans. These devices shall be tested to ensure that they are working properly before connecting them to the controller.

6. Priority Control Detection System, Traffic Signal Preemption.

A priority control detection system shall provide communication to the traffic signal controller that will allow the controller to run a modified signal timing plan to allow an emergency vehicle or another priority vehicle to pass through a roadway intersection with as little delay as possible. The priority control system shall be either acoustically (sound) activated, optically activated, or GPS (Global Positioning System) activated. The system shall include all mounting hardware, wiring, detection sensors, signal control devices and miscellaneous materials required to provide a fully functional priority control system for traffic signal preemption.

The system shall be capable of providing preemption information to the standard NEMA TS1, NEMA TS2, Type 170, and Type 2070 traffic controllers used by ALDOT.

A four-hour training session shall be provided for as many as ten attendees. The Contractor shall arrange for the training to be provided by a representative of the manufacturer of the priority control detection system. Training shall be instruction in the proper installation, operation, maintenance, and programming of the priority control detection system.

A training course outline shall be submitted to the Engineer for approval by ALDOT Maintenance Bureau Traffic Operations Engineer. Training will not be scheduled by the Engineer until the course outline is approved. Training shall be performed both in the field and in the office. The Contractor shall schedule the training during the time frame designated by the Engineer. The Contractor shall provide a minimum of a seven-calendar day advance written notice of the scheduling of the training to allow the Engineer to arrange attendance. A training notebook shall be provided to each trainee in a labeled three-ring binder.

(q) Installation of Conduit.

Metallic conduit shall be used above ground and may be used below ground.

Non-metallic conduit shall only be used underground.

Where non-metallic conduits join metal conduits, connection shall be made using appropriate couplings to form a watertight raceway. All conduits entering concrete foundations shall be provided with appropriate bushings at the ends. Conduits shall be stubbed approximately 1 inch {25 mm} above concrete and shall be provided grounding type bushings on conduit ends in base of poles with copper bonding jumpers.

Bends and offsets shall be avoided where possible, but where necessary, shall be made with a proper hickey, pipe bender, or conduit bending machine. Conduit that has been crushed or deformed due to improper bending or handling shall not be installed.

Conduits shall be installed in a manner to ensure against trouble from collection of trapped condensation where possible.

Conduits shall be capped to prevent entrance of deleterious materials during construction. For underground conduit adjacent to gasoline service stations or other installations of underground gasoline or diesel storage, piping or pumps, and which lead to a cabinet, circuit breaker panel, service, or any enclosure where an arc may occur during normal operation, the Contractor shall refer to the National Electrical Code (NEC) for Class 1, Hazardous Locations.

Conduit for future use shall be threaded and capped.

All conduit installed under paved areas shall be encased.

Encasement shall meet the requirements of Section 756 and shall be a Type 1, Type 2, or Type 5 installation as shown on the plans.

If the Contractor should encounter extraordinary circumstances such as major utilities under existing pavement which the location cannot be accurately determined, he may request in writing permission to open cut a trench in lieu of jacking or boring. This request shall also include detailed proposed sequence of excavating, backfilling, method of handling traffic, etc. for the Engineer's consideration. No such work shall be performed without written permission of the Engineer.

All conduit systems shall be completely installed before the conductors are installed.

(r) Luminaires.

The light control surfaces and lens shall be cleaned after installation.

Cleaning shall be performed in accordance with luminaire manufacture’s recommendations.

Luminaires shall be leveled, plumbed, and installed as per the manufacturer's recommendations and as directed by the Engineer to achieve the most suitable light pattern.

(s) Wiring Installation Requirements.

Wiring within junction boxes shall be neatly arranged and laced.

Powdered soapstone, talc, or other approved lubricant may be used in pulling cable in conduit.

All cables within a single conduit shall be pulled at the same time.

All ends of cable shall be taped to exclude moisture and shall be so kept until splices are made and terminal appliances attached.

The ends of spare conductors shall be taped.

All conductor splices that will be direct buried in earth and all loop detection conductor splices shall be soldered and encased in an approved splicing kit and with sealing tape.

All other signal conductor splices shall be spliced using a twisted connection made by a suitable wire nut or crimp and then properly covered by insulating tape or other insulating materials.

(t) Grounding Enclosures.

All metal enclosures containing electric wires and/or equipment shall be bonded to the chassis ground.

Ground rods shall be installed at all service equipment and traffic signal pole foundations.

Single ground rods shall be driven vertically until the top of the rod is at least 12 inches {305 mm} below the finished grade.

Where a grounding conductor passes through a metal conduit, a suitable grounding bushing shall be placed on each end of the conduit and connected to a ground wire.

Each messenger cable shall be attached to the supporting structure with separate span wire clamps.

(u) Excavating and Backfilling.

All excavation required for the installation and placement of conduits, foundations, junction boxes, poles and other appliances shall be performed in such manner as to cause the least possible injury to pavement, curbs or other improvements. All conduits required under pavement, sidewalks, etc. shall be in place prior to commencing of base and paving operations. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliance and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur.

Should large rocks be encountered in conduit trenches, they shall be removed to a depth of 3 inches {75 mm} below the proposed elevation and replaced with a 3 inch {75 mm} layer of suitable material. All suitable material removed from the conduit trenches shall be used in backfilling of the trenches; however, no stone larger than 3 inches {75 mm} shall be in contact with any conduit.

All surplus excavated material shall be removed from and disposed of by the Contractor, as directed by the Engineer.

Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

Compaction shall be accomplished to the extent necessary to prevent future settlement of the backfill.

The Contractor will be required to restore any areas disturbed by his work to their original condition without additional cost to the State.

(v) Insulation, Circuit Continuity and Ground Resistance Testing.

1. Insulation Testing.

Isolation test for testing insulation resistance shall be performed for each conductor in the cable. Testing shall be made using Article 110-19 of the NEC, as a guide. If resistance measured with all protective devices in place is less than 250,000 Ω, the contractor shall remove the defective cable, install new cable, and repeat the test.

For interconnect cable, upon completion of run from one controller installation to the next controller installation, the Contractor shall conduct a test for insulation resistance in the presence of the Engineer.

2. Circuit Continuity Test.

Each circuit branch shall be temporarily jumpered at its termination and the temporarily loop circuit measured for continuity to assure that no open circuits exist, that the circuit branch is

according to plan, that no high resistance connections exist and that each circuit is properly identified. Each circuit shall be marked with typed labels. Lead-in cable for loop detector wire shall be tested before and after the cable is spliced to the loop wire. As an alternative, circuit continuity testing of signal head cable may be done by applying 120 V to each outgoing circuit and observing that only the proper lamps are lighted.

3. Ground Resistance Test.

At each ground rod location, a test shall be made. The effectiveness of the ground rod shall be determined by measuring resistance from the pole enclosure to a convenient underground water line, with a 0-50 ohm megger where a water line is available and with auxiliary ground method where the water line is not available. The two auxiliary ground rods shall be not less than 50 feet and 100 feet {15 m and 30 m}, respectively, from the tested rod. If reading is greater than 5 ohms, additional rods shall be installed until a reading of 5 ohms or less is obtained.

(w) Operational Check and Adjustment of Equipment.

A full operational check of the installed traffic control system shall be performed under actual traffic conditions. Before the operational check is allowed to begin the Engineer will arrange for an inspection of the installed traffic control equipment by the Maintenance Engineer in coordination with the State Signal Shop. The Engineer will obtain the approval of the Maintenance Engineer to begin the operational check.

The period of operational check shall cover 30 calendar days. During the test period the Contractor shall expeditiously perform any necessary adjustment and replace any malfunctioning parts of the equipment required to place the system in an acceptable operational condition. Once repairs have been started, the Contractor shall have the traffic control equipment in an acceptable operational condition before leaving the project site. No extra compensation will be allowed for any work so required, such being considered incidental to furnishing and installing a complete operational signal system.

During the test period, time charges shall be suspended if all other work has been completed and acceptance of the work is dependent upon the results of the "operational check." The period of the test shall cover 30 continuous calendar days.

In case of emergency or failure on the Contractor's part to expeditiously pursue repairs, the Department reserves the right to make such repairs as it deems necessary. The cost for this work will be deducted from the contract bid amount for the project. The Department will not assume responsibility for the repairs or alter any of the requirements of the test period because of the repairs. The aforementioned shall in no way relieve the Contractor of his liability or responsibility related to maintaining the traffic signal as required by these specifications.

730.04 Method of Measurement.

(a) Removal of Traffic Control Unit.

The removal of all traffic control equipment at an intersection or other location designated on the plans will be measured as a Lump Sum, Removal of Traffic Control Unit. Removal of only some of the equipment will be measured as a Lump Sum, Removal of Traffic Control Unit (Partial). Removal of a temporary installation of traffic control equipment will be measured as a Lump Sum, Removal of Traffic Control Unit (Temporary). (Pay Item 730-A)

(b) Furnishing and Installing Traffic Control Unit.

Where separate pay items are not listed for the traffic control equipment required at a single intersection or other location designated on the plans, all of the traffic control equipment will be measured for payment as a Lump Sum, Furnishing and Installing Traffic Control Unit.

(c) Summary of Traffic Control Equipment Pay Items.

Traffic control items of work will be measured for payment in accordance with the following:

Pay items 730-A, C, S, U and Y will be measured per lump sum.

Pay items 730-E, F, G, J, K, N, O, P, Q, R, and T will be measured per each.

Pay items 730-H, I, L, and M will be measured per linear foot {meter}.

730.05 Basis of Payment.

(a) Unit Price Coverage.

Item 730-A. The accepted work for the removal of existing traffic control units will be paid for at the contract unit price which shall be full compensation for the satisfactory removal and storage of the equipment and materials ordered removed, and shall include all equipment, tools, labor, services, storage facilities and incidentals necessary to complete the work.

Item 730-C. The furnishing and installing the traffic control unit will be paid for at the contract unit price, which shall be full compensation for the furnishing of the equipment, installation in accordance with these Specifications, plans, proposal, and details, and for all tools, equipment, labor, materials, operational facility connected to the local utility.

Item 730-E. A Metal Traffic Signal Pole Foundation will be paid for at the contract unit price (adjusted to account for changes in size and reinforcement) which shall be full compensation for excavation, backfilling, forming, concrete, reinforcing steel, anchor bolts, ground rods, seeding and mulching of disturbed areas, disposal of debris and for all materials, labor, equipment, tools, testing, services and incidentals necessary to complete this item of work.

The bid price shall be for a 3'-0" {910 mm} diameter by 10'-0" {3.05 m} deep foundation. A larger foundation may be required. The reinforcing steel required for a larger foundation is shown on the plans. Compensation for a larger foundation will be made in accordance with the following cost adjustments.

COST ADJUSTMENT MADE TO BID PRICE FOR CHANGE IN FOUNDATION SIZE * ("+" plus figures are price increases)			
	Foundation Diameter		
Foundation Depth	3'-0" {910 mm}	3'-6" { 1.07 m}	4'-0" {1.22 m}
10'-0" {3.05 m}	$0	+$450	+$1200
11'-0" {3.35 m}	+$100	+$600	+$1400
12'-0" {3.66 m}	+$200	+$750	+$1600
13'-0" {3.96 m}	+$300	+$900	+$1800
14'-0" {4.27 m}	+$400	+$1050	+$2000
15'-0" {4.57 m}	+$500	+$1200	+$2200
16'-0" {4.88 m}	+$600	+$1350	+$2400
17'-0" {5.18 m}	+$700	+$1500	+$2600
18'-0" {5.49 m}	+$800	+$1650	+$2800
* Adjustments include compensation for changes to the reinforcing steel that are shown on the plans for larger foundations.			

The bid price adjustment shown above includes compensation for all work and materials (including reinforcing steel) necessary to construct the required foundation in accordance with the plan details. The Engineer may increase the amount of reinforcing steel from what is shown in the plan details. When the amount of reinforcing steel is increased from what is shown in the plan details, the bid price will be adjusted. The adjustment will be $1.00 per pound {$2.20 per kg} for the amount of reinforcing steel that is increased.

Item 730-F. A Metal Traffic Signal Pole with Mast Arm Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing the metal traffic signal pole and mast arm assembly and for all materials, equipment, tools, labor, services, and incidentals necessary to complete this item of work. The required foundation shall be measured separately with payment being made under Item 730-E.

Item 730-G. A Traffic Signal Pole will be paid for at the contract unit price which shall be full compensation for furnishing and installing the traffic signal pole, and for all materials, equipment, tools, labor, services, and incidentals necessary to complete this item of work. The required foundation shall be measured separately with payment being made under Item 730-E.

1. Traffic Signal Pole (Wood Strain). A Wood Pole will be paid for at the contract unit price which shall be full compensation for furnishing and installing the wood pole, excavating, backfilling, attachment hardware, grounding, conduit (down to the base of the pole), weatherhead, guy wire, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item of work.
2. Traffic Signal Pole (Type) (State Furnished). A State Furnished Pole will be paid for at the contract unit price which shall be full compensation for delivery and installation of the traffic signal pole, and for all materials, equipment, tools, labor, services, and incidentals necessary to complete this item of work. The required foundation shall be measured separately with payment being made under Item 730-E.

Item 730-H. Loop Wire will be paid for at the contract unit price which shall be full compensation for the saw cutting, loop wire, loop sealant, trenching, backfilling, electrical connections, splicing, and for all materials, labor, equipment, and tools to provide a complete and operational loop detector.

Item 730-I. Loop Detector Lead-In Cable will be paid for at the contract unit price which shall be full compensation for furnishing and installing the shielded home-run cable, including electrical connections and for all materials, equipment, tools, labor, testing, and incidentals necessary to provide a complete and operational detector loop.

Item 730-J. A Vehicle Loop Detector will be paid for at the contract unit price which shall be full compensation for furnishing and installing the loop detector amplifier, electrical connections and for all materials, equipment, tools, labor and incidentals necessary for a complete and operational loop detector amplifier.

Item 730-K. A Traffic Signal Junction Box will be paid for at the contract unit price which shall be full compensation for furnishing and installing the junction box, excavation, concrete, backfilling, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

Item 730-L. Conduit will be paid for at the contract unit price which shall be full compensation for furnishing and installing the conduit including fittings, trenching, placing, joining, attaching to structure, backfilling, seeding and mulching of disturbed areas, disposal of debris, and all materials, labor, equipment, tools and incidentals necessary to complete this item of work.

Item 730-M. Interconnect Cable will be paid for at the contract unit price which shall be full compensation for furnishing and installing the interconnect cable with the number of conductors and type as designated by the plans, including all hardware for aerial installation, connecting to controller assemblies, splicing, electrical connections, and for all materials, testing, labor, equipment, tools, and incidentals necessary for a complete and functional interconnect cable.

Item 730-N. A Luminaire Extension Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing the luminaire arm, sodium vapor or LED luminaire, surge arrestor, connections, ground rod, No. 10 AWG, cable, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operational luminaire.

Item 730-O. Illuminated Sign Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing a regulatory or warning sign with accompanying vehicular signal head or embedded flashing LEDs including all attachment hardware, connections, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operational illuminated sign.

Item 730-P. A Signal Head will be paid for at the contract unit price which shall be full compensation for furnishing and installing the signal head, trunnions, brackets, attachment hardware, backplate, connections, splicing, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operational signal head.

1. Signal Head, Vehicular. A backplate shall be furnished with a required vehicular signal head. The required backplate for existing signal head shall be measured separately with payment under Item 730-Q.

Item 730-Q. Miscellaneous Equipment will be paid for at the contract unit price which shall be full compensation for furnishing and installing the equipment including any applicable attachment or mounting hardware, or wiring, and for all materials, labor, equipment, tools, and incidentals necessary for a complete piece of equipment that operates as the manufacturer intends or as otherwise indicated in the plans or specifications.

Item 730-R. A Controller Assembly will be paid for at the contract lump sum price which shall be full compensation for furnishing and installing the cabinet, controller unit, auxiliary devices, electrical devices, surge protection, terminals, concrete foundation or side mounting hardware, mounting and wiring of controller assembly, and for all materials, labor, equipment, tools, testing, and incidentals necessary for a complete and operational controller assembly.

Item 730-S. Traffic Signal Preemption will be paid for at the contract lump sum price which shall be full compensation for furnishing and installing all mounting hardware, wiring, detection sensors, signal control devices, software (when required), testing and miscellaneous materials required to provide a fully functional priority control system for traffic signal preemption. If software and training is required it will be shown in the pay item description. Payment for training shall be full compensation for training personnel, supplies, equipment, materials, user manuals, handouts, travel, and subsistence necessary to conduct the training.

Item 730-T. The furnishing and installation of the Electrical Power Service Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing the wood

pole (where required), excavating, backfilling, attachment hardware, grounding, weatherhead, guy wire, conduit (down to the base of the pole), photoelectric control unit, conductors, and other necessary materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

1. Uninterruptable Power Supply Systems will be paid for at the contract unit price which shall be full compensation for furnishing and installing the cabinet, auxiliary devices, electrical devices, terminals, concrete foundation or side-mounting hardware, mounting and wiring of the system, battery bank, inverter/converter, and other necessary materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

Item 730-U. Detection Systems will be paid for at the contract unit price which shall be full compensation for the following systems:

1. Video Detection System. Cameras, lenses, enclosures, mounting brackets, video, communication, and power cabling, power supplies, lightning protection; manuals and documentation and for all labor, materials, tools, equipment, transportation and incidentals necessary for a complete and operational vehicle detection system. The contract unit price shall also be full compensation for furnishing and installing the vehicle detection system processor, interface panel, and for all integration (including software setup and programming and adjusting detection zones).
2. Radar Detection System. Radar units, enclosures, mounting brackets, communication and power cabling, power supplies, lightning protection; manuals and documentation and for all labor, materials, tools, equipment, transportation and incidentals necessary for a complete and operational vehicle detection system. The contract unit price shall also be full compensation for furnishing and installing the vehicle detection system processor, interface panel, and for all integration (including software setup and programming and adjusting detection zones).
3. Magnetometer Detection System. Magnetometers, communication equipment, enclosures, mounting brackets, communication and power cabling, power supplies, lightning protection; manuals and documentation and for all labor, materials, tools, equipment, transportation and incidentals necessary for a complete and operational vehicle detection system. The contract unit price shall also be full compensation for furnishing and installing the vehicle detection system processor, interface panel, and for all integration (including software setup and programming and adjusting detection zones).
4. Hybrid Detection System. Combination Video/Radar units, enclosures, mounting brackets, communication and power cabling, power supplies, lightning protection; manuals and documentation and for all labor, materials, tools, equipment, transportation and incidentals necessary for a complete and operational vehicle detection system. The contract unit price shall also be full compensation for furnishing and installing the vehicle detection system processor, interface panel, and for all integration (including software setup and programming and adjusting detection zones).

Item 730-Y. Pedestal Pole and Foundation will be paid for at the contract unit price which shall be full compensation for the following:

1. Installation. Furnishing, fabricating, galvanizing, assembling and erecting a complete and operational roadside flashing beacon assembly, a complete and operational illuminated sign assembly, or a complete and operational pedestrian signal control assembly including, but not limited to signal head(s), illuminated or static sign(s), pedestrian pushbutton(s), cabinet, installing foundations, furnishing and placing anchor bolts and hardware, controller, wiring, power source, connection to local utility and equipment, materials, labor, tools and incidentals.

2. Relocation. Removing the flashing beacon assembly, illuminated sign assembly, or pedestrian signal assembly; removing existing foundations; installing new foundations; furnishing and placing anchors; hardware; excavation and surface placement; furnishing, fabricating, and installing new components as required and replacing the assembly on its new foundation with all manipulations and electrical work; controller; power source; connection to local utility; loading and hauling; and equipment, materials, labor, tools, and incidentals.

3. Removal. Removing the roadside assembly components including the power service equipment; removing the foundations; storing the component to be reused or salvaged; backfilling and surface placement; loading and hauling, and equipment, materials, tools, labor, and incidentals.

(b) Payment will be made under Item No.

730-A Removal of Existing Traffic Control Unit *(1) (2)* - per lump sum

730-C Furnishing and Installing Traffic Control Unit *(2)* - per lump sum
730-E Metal Traffic Signal Pole Foundation – per each
730-F Metal Traffic Signal Pole with *(3)* Mast Arm Assembly - per each
730-G Traffic Signal Pole, (4), (5) - per each
730-H Loop Wire - per linear foot {meter}
730-I Loop Detector Lead-In Cable - per linear foot {meter}
730-J Vehicle Loop Detector - per each
730-K Traffic Signal Junction Box - per each
730-L *(6), (7),* Conduit - per linear foot {meter}
730-M Interconnect Cable, *(8), (9)* AWG, *(10), (11)* - per linear foot {meter}
730-N Luminaire Extension Assembly, *(12)* feet {meters} - per each
730-O Illuminated Sign Assembly (13) (14) - per each
730-P *(15)* Signal Head, *(16)* Section, Type *(17)* - per each
730-Q Miscellaneous Equipment, (16) – per each
730-R Controller Assembly, Type *(18), (19)* Output Phase Channels - per each
730-S *(20)* Traffic Signal Preemption *(21) (22) (2)* – per lump sum
730-T Electrical Power Service Assembly (23) – per each
730-U *(24)* Detection System *(2)* – per lump sum
730-Y *(25)* Pedestal Pole and Foundation with *(26)* – per lump sum

(1) Specify Partial or Temporary if required
(2) Specify Intersection Location
(3) Specify Length of Mast Arm
(4) Specify Type (Metal Strain, Concrete Strain, Wood Strain, Pedestal)
(5) Specify State Furnished if required
(6) Specify Size (1 inch, 2 inch, or 3 inch) {27 mm, 53 mm, or 78 mm}
(7) Specify Type (metallic or non-metallic)
(8) Specify Type (Aerial Self-supporting, Aerial Lashed, or Underground)
(9) Specify Cable Size (No. 14 AWG or No. 19 AWG)
(10) Specify Number of Conductors or Pairs (9 Conductors or 6 Pairs)
(11) Specify (IMSA 20-1, IMSA 20-3, REA PE-22, REA PE-38, or REA PE-39)
(12) Specify Arm Length in Feet {Meters}
(13) Specify Lighting Method (with Flashing Beacon, or With Embedded LEDs)
(14) Specify Power Source (Solar, or Utility Powered)
(15) Specify Vehicular or Pedestrian
(16) Specify Type (Backplate for Existing Signal Head, Pedestrian Push Button, Pedestal Pole and Foundation)
(17) Specify Type (Incandescent, Optically Programmed, or LED)
(18) Specify Type (NEMA or ATC)
(19) Specify Number of Output Channels (8, 16, or 32)
(20) Specify Type (Acoustical, Optical or GPS)
(21) Specify Whether or not Software is Required (With Software, or Without Software)
(22) Specify Whether or not Training is Required (With Training, or Without Training)
(23) Specify Whether or not Wood Pole is Required (With Wood Pole or Without Wood Pole)
(24) Specify Type [Video, Radar, Magnetometer, or Hybrid (Video/Radar)]
(25) Specify (Furnishing and Installing, Removal of, or Relocation of)
(26) Specify (Flashing Beacon, Pedestrian Signal Features, or Illuminated School Zone Sign)

SECTION 731
TRAFFIC COUNTING EQUIPMENT

731.01 Description.

This Section shall cover the work of furnishing and installing, complete in place, traffic counting equipment as shown on the plans, at locations shown on the plans, all in accordance with the details shown on the plans and these Specifications.

For the purpose of these Specifications traffic counting equipment will be classified as operational units. Traffic Counting Units shall be classified by “Type” which will designate the number and design of the loops, etc., in accordance with details shown in the plans.

For the definition of equipment, words, and terminology used in the furnishing and installing of Traffic Counting Equipment, refer to the appropriate publications of the Institute of Transportation Engineers (I.T.E.) and to the Manual of Uniform Traffic Control (MUTCD).

731.02 Materials.

(a) General.

Material and equipment listings shall be furnished to the Engineer within thirty days after the issuance of the “Notice to Proceed”. The Contractor shall submit to the Transportation Planning Bureau’s Traffic Monitoring Section for approval, five copies of a complete list of all materials and equipment. Partial listings will not be accepted for consideration. Material and equipment lists shall include catalog cutouts or published data sheets and a completed Material Submittal Form. Unacceptable submittal data will be returned for corrective action. Three copies of the approved material and equipment listings will be returned to the Contractor and one approved copy will be sent to the Construction Bureau.

Any changes to the approved material or equipment lists shall be requested in writing through proper channels. If requested by the Engineer, the Contractor shall submit for inspection and approval samples of both the specified and proposed substitute item at no cost to the Department. Materials and equipment installed or used without prior approval of the Engineer shall be at the risk of subsequent rejection. The State shall not be liable for materials purchased, work performed, or any delay incurred due to the failure of the Contractor to secure prior approval. Failure of the Engineer to note unsatisfactory material as received will not relieve the Contractor of responsibility.

Manufacturers' warranties and guaranties furnished on material and equipment used in the work shall be delivered to the Engineer; likewise, instruction sheets and parts listed supplied shall be delivered to the Engineer upon receipt of the equipment.

Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of material and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Whenever any article, material, or equipment is defined by describing a proprietary product or by using the name of a manufacturer or vendor, the term "or approved equal" if not inserted, shall be implied.

Electrical materials shall conform to the Standards of the National Electrical Manufactures Association (NEMA) and/or the Underwriters Laboratories, Inc. (UL), in every case where a standard has been established for that particular article, material, or equipment.

All material and equipment shall be of the best quality and workmanship and shall be new unless otherwise noted on the plans. Throughout the entire project, all units of any one item, such as enclosures, and associated equipment, etc., shall be made by the same manufacturer.

Inasmuch as certain materials and equipment furnished for use under this Section will be standard production type products, acceptance will be made by the Engineer based on selected confirmation tests, the manufacturer's certification of the material and/or design conformance to the requirements noted in this Section, details shown on the plans, and visual inspection at the job site. The manufacturer shall make available to the Department test data and material samples from the production runs for use in evaluation of their product.

Title 32, Chapter 5A, Subsection 36 of the Code of Alabama states that all traffic control devices shall be approved by the Transportation Director before they can be used, sold, or offered for sale. Approved products can be found in the Departments "Materials, Sources, and Devices With Special Acceptance Requirements" manual. The Contractor may choose from any of these products, unless otherwise noted. Refer to Subarticle 106.01(f) and BMTP-355 concerning this list.

(b) Terminal Strip Enclosure.

Terminal Strip Enclosure shall include, but not limited to, the enclosure, terminal strips, pin connectors, ground rod, ground rod clamp, ground wire, and ground lug. Terminal Strip Enclosure and associated equipment shall conform to the detailed plans.

(c) Loop Wire.

Loop wire conductors shall be stranded soft annealed stranded wire of not less than 98 percent conductivity and shall be insulated for 600 volts or more with a cross-linked polyethylene insulation. Conductors shall be Type RHH or RHW or Use or XHHW.

(d) Conduit Systems.

1. Non-Metallic Conduit.

Non-metallic conduits shall be Type II, Schedule 40, PVC unless otherwise noted on the plans. All non-metallic conduits and fittings shall conform to UL Standard 651 or NEMA TC-2 latest edition.

2. Liquidtight Flexible Metal Conduit.

Liquidtight flexible metal conduits shall conform to UL listed Type UA for the intended use.

(e) Terminal Strip Enclosure Support.

The Terminal Support Enclosure support structure shall be in accordance with the details shown on the plans and meet the requirements of Article 840.04.

(f) Pole For Mounting Traffic Detection Equipment.

The structural design, submittal, material, and fabrication requirements given in Sections 730, 718 and 891 shall be applicable to the furnishing and installation of a pole that is required for the mounting of traffic detection equipment.

731.03 Construction Requirements.

(a) General.

All required material and equipment shall be installed in accordance with the manufacture's recommendations, details shown in the plans, and as designated in the proposal. All installations shall comply with the regulations of the latest edition of the National Electrical Code (NEC) and the latest edition of the National Electrical Safety Code.

Coordination of this work with regular roadway or bridge work will be of prime importance to prevent undue damage to completed items of work or existing facilities. Any damage to existing facilities caused by the installation of the material and/or equipment required under this section of work, shall be repaired by the Contractor at no additional cost to the State.

After all equipment has been installed and an operational check has been instigated, the Contractor shall furnish the Engineer with a corrected set of plans showing in detail all changes on construction from the original plan details.

(b) Grounding.

All metal enclosures containing electric wires and/or equipment shall be grounded. Ground rods shall be installed at all the terminal strip enclosure. Single ground rods shall be driven vertically until the top of the rod is at least 12 inches {305 mm} below the finished grade. A length of No. 4 bare soft drawn copper shall be attached to the ground rod clamp as shown on the plan details. Where a grounding conductor passes through a metal conduit, a suitable grounding bushing shall be placed on each end of the conduit and connected to the ground wire.

Where non-metallic conduit is used, a separate continuous grounding conductor shall be extended from the service ground to all equipment and shall be used for grounding purposes only.

Testing of Grounding System: The effectiveness of the ground rod shall be determined by measuring resistance from the pole enclosure to a convenient underground water line, with a 0-50 ohm megger (J.H. Biddle Company or equal) where a water line is available and with auxiliary ground method where the water line is not available. The two auxiliary ground rods shall be not less than 50 feet and 100 feet {15 m and 30 m}, respectively, from the tested rod. If reading is greater than 25 ohms, additional rods shall be installed until a reading of 25 ohms is obtained.

(c) Wiring.

All wiring shall be installed in a neat and workmanlike manner. Wiring within enclosure cabinet shall be neatly arranged and laced. Loop wire shall be one continuous run without splicing. All ends of cable shall be taped to exclude moisture and shall be so kept until terminal strips are attached.

(d) Loop Wire Installation.

A conduit run shall be completely installed before the installation of wire. Wires in conduits shall be carefully pulled into place using approved methods so that the cable will be installed free from any electrical or mechanical injury. Powdered soapstone, talc, or other inert lubricant specifically designed for the purpose shall be used. A conduit run shall be completely installed before the installation of wire. Wires in conduits shall be carefully pulled into place using approved methods so that the cable will be installed free from any electrical or mechanical injury. Conductors shall be handled and installed in such a manner as to prevent kinks, bends or other distortion which could damage the conductor or outer covering. All cables within a single conduit shall be pulled at the same time.

Loop wire shall be installed in slots cut in the pavement, at locations designated on the plans or as directed by the Engineer. The slot shall be formed by sawing pavement with approved equipment designed for sawing pavement, to the width and depth indicated by the plan details or directed. The slot shall be cleaned of all foreign loose debris using compressed air or other approved means before installation of the loop wire. After installation of the loops, the slots shall be sealed with an approved sealant manufactured specifically for embedding loop detector wire in concrete or bituminous pavements.

All conductors installed under paved areas shall be encased. Installation of the casing shall be made either prior to placement of the pavement with thick wall rigid metallic or rigid casing, or it shall be jacked or bored through the roadbed under the pavement using thick wall rigid metallic casing providing a minimum cover of 30 inches {762 mm}.

The sealant proposed for use shall be shown in the proposed list of materials to be used.

(e) Conduit System Installation.

Conduits shall be joined by approved fittings using methods prescribed the manufacturer of the conduit. Where non-metallic conduit join metal conduits, connection shall be made using appropriate couplings to form a watertight raceway. Bushings shall be installed as shown on the plan details. Underground conduit shall be installed as shown on the plans with a minimum cover of 30 inches {762 mm }.

When rock is encountered in the in the bottom of the trench, the conduit shall be installed in a bed of well compacted, fine grained soil at least 2 inches {50 mm} thick. If 30 inches {762 mm} cannot be attained, convert the conduit to asphaltum painted metallic conduit installed as deep as practical but no less than 6 inches {152 mm}. Seeding and mulching of disturbed areas shall be backfilled and compacted to prevent future settling. Seeding and mulching of disturbed areas shall be as directed by the Engineer as a subsidiary obligation of the conduit installation.

Precautions shall be taken to be sure that the conduit will be located to avoid conflict with proposed guardrail, signpost, etc. Where possible, a minimum of 12 inches {305 mm} shall be provided between the finished lines of conduit runs and utility facilities, such as gas lines, water mains, or other underground facilities not associated with the electrical system. Where the conduit run is adjacent to concrete walls, piers, footings, etc., a minimum of 4 inches {102 mm} of undisturbed earth or firmly compacted soil shall be maintained between the conduit and the adjacent concrete.

Unless specified on the plans, trenches shall not be excavated in existing pavement or paved shoulders to install conduit. When it is necessary to place conduit under an existing pavement, the conduit shall be installed in accordance with Section 756. Unless approved otherwise by the Engineer, no trenches shall remain open after normal work hours each day. All trenches shall be protected from the accumulation of water which might cause an undermining of adjacent structures or utilities. The Contractor shall adequately support all pipes and other structures exposed in trenches.

(f) Excavating and Backfilling.

Before beginning any excavation, the Contractor shall determine the location of any electrical, drainage or utility lines in the vicinity and shall conduct his work in such a manner as to avoid damage to the same.

All excavation required for the installation and placement of conduits and other materials shall be performed in such manner as to cause the least possible injury to pavement, curbs or other improvements. All conduits required to be under pavement, sidewalks, etc. shall be in place prior to commencing of base and paving operations. The trenches shall not be excavated wider than necessary for the proper installation of the material. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur.

Should large rocks be encountered in conduit trenches, they shall be removed to a depth of 3 inches {75 mm} below the proposed elevation and replaced with 3 inches {75 mm} layer of suitable material. All suitable material removed from the conduit trenches shall be used in backfilling of the trenches; however, no stone larger than 3 inches {75 mm} shall be in contact with any conduit.

All surplus excavated material shall be removed from and disposed of by the Contractor, as directed by the Engineer.

Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well drained condition until permanent repairs are made.

The Contractor will be required to restore any areas disturbed by his work to their original condition without additional cost to the State.

(g) Encasement.

All encasement shall meet the requirements of Section 756 and the requirements set forth in this proposal.

If the Contractor should encounter extraordinary circumstances such as major utilities under existing pavement which the location cannot be accurately determined, he may request in writing permission to open cut a trench in lieu of jacking or boring. This request shall also include a detailed proposed sequence of excavating, backfilling, method of handling of traffic etc. for the Engineer's consideration. No such work shall be performed without written permission of the Engineer.

(h) Installation of a Pole for Mounting Traffic Detection Equipment.

A pole required for mounting traffic detection equipment shall be installed in accordance with the requirements given in Section 730 and the details shown on the plans.

731.04 Guarantee.

The Contractor shall guarantee all work performed under this Section, against defective materials and workmanship for a period of six (6) months after the final acceptance of the project. The Contractor shall replace materials and workmanship found defective during the guarantee period at no cost to the State.

731.05 Method Of Measurement.

Furnishing and installing of traffic counting equipment when so scheduled on the plans or proposal shall be measured in complete units in accordance with the following:

Each complete operational traffic counting facility will be measured separately with single locations classified as units.

Poles for mounting traffic detection equipment will be measured per each pole.

731.06 Basis of Payment.

(a) Unit Price Coverage.

The accepted work of furnishing and installing the traffic counting units measured as noted above, shall be paid for at the contract price bid per each, which shall be full compensation for the furnishing of the traffic counting unit terminal strip enclosure, conduit, encasing, grounding materials, loop wire and sealant, and all incidentals necessary for furnishing in accordance with plan details; and for all tools, equipment, labor to complete the installation.

Each pole for mounting traffic detection equipment will be paid for at the contract unit price which shall be full compensation for all materials tools and labor required for the design, fabrication and installation of the pole. The contract unit price shall also be full compensation for the foundation and all appurtenances shown to be required on the plans. Compensation for the pole will be adjusted in accordance with the cost adjustments listed in Section 730.05 for changes to the size of the pole foundation.

(b) Payment will be made under Item No.:

731-A Traffic Counting Units, Type ____ per Each
731-B Pole for Mounting Traffic Detection Equipment - per Each

SECTION 734
REMOVAL AND RELOCATION OF INTELLIGENT TRANSPORTATION SYSTEMS

734.01 Description.

The work under this Section shall cover the work of decommissioning, removal (wholly or in part), the satisfactory salvaging or disposal of, or the relocation of Intelligent Transportation Systems (ITS) infrastructure and/or equipment as designated on the Plans or in the Proposal. Salvaging of materials for reuse by the State will be required only when such is designated by the Plans or Proposal; otherwise, the materials shall become the property of the Contractor.

Quantities and limits of this type of work indicated on the Plans are approximate only, subject to the Engineer’s evaluation of the actual site condition.

734.02 Materials.

All new ITS materials required shall meet the applicable requirements of **Section 729** and **Section 893**. All other new materials required shall meet the applicable requirements of **Division 800, Materials**.

(a) Wood Pole (Service Pole).

Wood Pole (Service Pole), required for relocation of electrical power service or aerial cable installation, shall be in accordance with these Specifications, Plans, National Electrical Code (NEC) requirements, National Electrical Safety Code (NESC) requirements, and local utility codes. The wood pole installation shall include guy wire(s), grounding system, and riser in accordance with **Article 893.13** "*Electrical Power Service and Transformer*".

Wood Pole shall be in accordance with **Sub-Article 893.11(a)** "*Service Pole (Wood Pole)*" material requirements.

Guy Wire (a.k.a. down guy) shall be in accordance with **Sub-Article 893.11(f)** "*Guy Wire*" material requirements.

Grounding and ground electrodes shall be in accordance with **Sub-Article 893.11(i)** "*Grounding*" material requirements.

734.03 Construction Requirements.

(a)Laws, Rules, Regulations and Ordinances.

The Contractor shall comply with all Federal, State, City, and County laws, rules, regulations, and ordinances covering moving, re-establishing, demolition, or disposal of ITS infrastructure, structures, and/or equipment, materials, and appurtenances.

Any utility service requiring disconnection or reconnection shall be done in accordance with: current local codes and practices of the type utility involved; the utility's regulations; and, shall meet the approval of the Utility.

(b) Fiber Optic Technician Qualifications.

For fiber optic infrastructure work, a qualified Fiber Optic Technician shall oversee said work. The Fiber Optic Technician shall be approved in accordance with **Item 729.03(b)1** "*Fiber Optic Technician Qualifications*" prior to commencing work.

(c)Removal of ITS Infrastructure and/or Equipment.

1. GENERAL.

Removal of ITS Infrastructure and/or Equipment shall consist of the demolition and disposal of the materials and associated equipment identified in the contract. It shall also include the restoration of the area of removal to a stable, uniformly graded ground surface.

Use of methods or equipment which might damage existing or completed infrastructure, infrastructure to be retained, or portions thereof, shall not be permitted.

The Contractor shall protect adjacent infrastructure, structures, utilities, and their contents that are designated to remain. Any damage due to negligence on the part of the Contractor shall be cause for the Engineer to order its replacement or repair. The cost of replacement or repair shall be borne fully by the Contractor.

Where Plans call for removal of existing ITS infrastructure and/or equipment to salvage or reuse elsewhere, the Contractor shall take care to prevent damaging the existing infrastructure/equipment during removal and adhering to all of the requirements of **Section 729** for installation that pertain to removal and handling (e.g., fiber optic cable minimum bending radius and tensile loading requirements, OTDR testing, etc.).

2. REMOVAL OF FIBER OPTIC CABLE.

All aerial fiber optic cable and associated equipment designated or directed to be removed shall be removed in such a manner that the existing supporting infrastructure will not be damaged.

All undergrade fiber optic cable and associated equipment designated or directed to be removed shall be removed in such a manner that the existing infrastructure will not be damaged unless otherwise noted on the Plans.

All fiber optic cable identified for removal shall be removed and not abandoned regardless if other roadway work would demolish it with their processes. Fiber optic cable identified for removal is considered a life/safety hazard waste upon removal and must be recycled and/or disposed of in accordance with any regulatory, statutory, or other State/Local requirements.

All fiber optic cable and associated equipment designated for removal shall NOT be removed until the existing equipment, data communications, and facilities have been relocated or

decommissioned as per the Plans. Removal shall not commence until so designated and approved by the Engineer.

Prior to any interruptions of fiber optic cable service, the Region Transportation Systems Management & Operations (TSM&O) Engineer and the Region Traffic Management Center (RTMC) Supervisor shall be contacted and schedules coordinated to minimize down time of the ITS and traffic signal system(s) being served by said fiber optic cable.

3. REMOVAL OF ITS INFRASTRUCTURE.

All ITS infrastructure and associated equipment designated or directed to be removed shall be removed in such a manner that the existing supporting infrastructure will not be damaged unless otherwise noted on the Plans.

All ITS infrastructure and associated equipment identified for removal shall be removed and not abandoned regardless if other roadway work would demolish it with their processes. All ITS infrastructure and associated equipment identified for removal shall be delivered, in working order without damage or blemish, to designated entity/office as indicated on the Plans. Any ITS items or components designated for disposal on the plans shall be recycled and/or disposed of in accordance with any regulatory, statutory, or other State/Local requirements.

All ITS infrastructure and associated equipment designated for removal shall NOT be removed until all required and relocated/existing supporting equipment, data communications, and facilities work has been completed as designated by the Plans. Removal shall not commence until so designated and approved by the Engineer.

Prior to any interruptions of ITS infrastructure and related service, the Region Transportation Systems Management & Operations (TSM&O) Engineer and the Region Traffic Management Center (RTMC) Supervisor shall be contacted and schedules coordinated to minimize down time of the ITS and traffic signal system(s) being served by said ITS infrastructure.

(d) Relocation of ITS Infrastructure and/or Equipment.

1. GENERAL.

Relocation of ITS Infrastructure and/or Equipment shall consist of the removal, storage, and re-installation of the materials and associated equipment identified in the contract. It shall also include: the restoration of the area of removal to a stable, uniformly graded ground surface; any testing or recommissioning of said equipment and or materials (e.g., OTDR and fiber optic testing, system/sub-system testing, Bench testing, Field testing, Acceptance testing, and/or Burn-In, etc.).

Use of methods or equipment which might damage existing or completed infrastructure, infrastructure to be retained, or portions thereof, shall not be permitted.

The Contractor shall protect adjacent infrastructure, structures, utilities, and their contents that are designated to remain. Any damage due to negligence on the part of the Contractor shall be cause for the Engineer to order its replacement or repair. The cost of replacement or repair shall be borne fully by the Contractor.

Where Plans call for relocation of existing ITS infrastructure and/or equipment to salvage or reuse elsewhere, the Contractor shall take care to prevent damaging the existing infrastructure/equipment during the removal, storage, and re-installation process; and, shall also adhere to all of the requirements of **Section 729** for installation that pertain to removal, installation and handling (e.g., fiber optic cable minimum bending radius and tensile loading requirements, OTDR testing, etc.).

Grounding and ground electrodes installation shall be in accordance with **Sub-Article 729.03(k)** "*Grounding, Lightning Protection, Insulation, and Circuit Continuity*".

2. OMIT (FUTURE USE).

3. WOOD POLE (SERVICE POLE).

Wood Pole (Service Pole), required for relocation of electrical power service or aerial cable installation, shall be installed in accordance with these Specifications, Plans, National Electrical Code (NEC) requirements, National Electrical Safety Code (NESC) requirements, and local utility codes. The wood pole shall be installed with guy wire(s), grounding system, and riser in accordance with **Sub-Article 729.03(m)** "*Electrical Power Service and Transformer*". The riser shall be an attached raceway with conduit and fittings where required for undergrade to aerial cable transitions.

Wood Pole shall be installed in accordance with **Item 729.03(m)1** "*Service Pole (Wood Pole)*".

Guy Wire (a.k.a. down guy) installation shall be in accordance with **Item 729.03(m)2** "*Guy Wire*".

Grounding and ground electrodes installation shall be in accordance with **Sub-Article 729.03(k)** "*Grounding, Lightning Protection, Insulation, and Circuit Continuity*".

(e)Abandoning of ITS Infrastructure and/or Equipment.

1. FOUNDATIONS.

All foundations, when abandoned, shall have the top of the foundation, anchor bolts frame and conduit removed to a depth of not less than 12 inches or as directed below the surface of existing pavement and/or established finish grade. The resulting hole shall be backfilled with material to match the existing surface.

2. CONDUIT.

All underground conduits, when abandoned, shall have the conduit entries/openings removed to a depth of not less than 12 inches or as directed below the surface of existing pavement and/or established finish grade. Any resulting holes shall be backfilled with material to match the existing surface.

(f) Disposal of Debris and Cleanup of Site After Removal and Relocation.

The Contractor shall remove and dispose of ITS infrastructure (e.g., fiber optic cable, etc.) and associated equipment designated for removal on the Plans. The disposal method and timeframe for disposal shall be approved by the Engineer in accordance with all applicable rules and regulations, project notes, and Sequence of Construction requirements.

Disposal of debris and materials not allowed for reuse shall be done in accordance with the requirements for disposal given in **Sub-Article 201.03(d)**.

After the removal of ITS infrastructure and/or equipment has been completed, the Contractor shall grade the area of removal to produce a stable, uniform ground surface. All trenches and excavations resulting from the removal of ITS infrastructure shall be backfilled with suitable materials placed in accordance with **Section 210**.

When clearing and grubbing is not a part of the contract, the Contractor shall obtain approval from the Engineer to cut trees that interfere with ITS infrastructure and/or equipment removal or relocation.

(g)As-Built Drawings.

The Contractor shall update as-built documentation of all work provided in accordance with these Specifications and the requirements set in **Item 729.03(a)4** "As-Built Drawings".

(h) Coordination of Work.

Coordination with roadway, traffic signals, and bridge work shall be of prime importance to prevent undue damage to completed items of work and to existing facilities. Any damage to existing facilities caused by the removal, relocation, or installation of the material or equipment required under this Specification shall be repaired by the Contractor at no additional cost to the Department.

The Contractor shall field verify equipment locations with the Engineer prior to commencing work.

(i) Restoration of Site.

The Contractor shall restore site(s) in accordance with these Specifications. During the removal or relocation of ITS infrastructure and/or equipment, removal of brush, trees, fencing, and other obstructions within the right-of-way, this work shall comply with **Section 210** and shall be paid for separately under that Section unless otherwise shown on the Plans. Landscaping shall be restored to original or better condition if disturbed.

(j) Excavating and Backfilling.

Excavation required for the removal, relocation and placement of ITS infrastructure and/or equipment (e.g., conduits, foundations, commboxes, ITS poles, etc.) shall be performed in such manner as to cause the least possible injury to pavement, curbs or other improvements.

Trenches shall not be excavated wider than necessary for the proper installation and/or removal of the conduits, wires and/or fiber optic cables. Excavating shall not be performed until immediately before removal and/or relocation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur. Any trenches required for construction shall be backfilled the same day. Surplus excavated materials shall be removed from the site the same day or stockpiled in accordance with **Section 210** and disposed of by the Contractor, as directed by the Engineer. Compaction shall be accomplished to the extend necessary to prevent future settlement of the backfill.

The Contractor shall be required to restore any areas disturbed by his work to their original condition without additional cost to the Department.

The Contractor shall fill all holes or pits resulting from removal operations with suitable material as approved by the Engineer. The backfilled areas shall be compacted to the density of the surrounding ground, or as specified.

734.04 Method of Measurement.

The Removal and Relocation of Intelligent Transportation Systems shall be measured for payment by the appropriate items complete, in place, acceptably removed and/or relocated (and where applicable: tested and operational) in accordance with the following:

ITEM 734-U: Wood Pole shall be measured per each.
ITEM 734-W: Relocation of ITS Infrastructure shall be measured per lump sum.
ITEM 734-X: Removal of Fiber Optic Cable shall be measured per lump sum.
ITEM 734-X: Removal of ITS Infrastructure shall be measured per lump sum.

734.05 Basis of Payment.

Unless otherwise indicated below, the payments shall be made in increments of:

1. Up to 70% of the contract unit price upon successful completion of the BENCH TEST and installation of item(s) [Partial payments may be made in accordance with **Article 109.07** up to this percentage.];
2. Additional 15% of the contract unit price upon completion of the FIELD TEST; and,
3. Final 15% of the contract unit price upon completion of the ACCEPTANCE TEST (BURN-IN).

(a)Unit Price Coverage.

ITEM 734-U. WOOD POLE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for furnishing, installing, and testing, complete in place, as shown on the Plans, with the following:

a. wood pole (service pole), guy wire(s), excavating, backfilling and seeding, attachment hardware, and grounding system;
b. weather head(s), vertical conduit(s) and riser;
c. Manufacturer and Contractor warranties;
d. and for all materials, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

[*Please Note:* Messenger Wire, Conductors, and Conduit are separate **Section 729** pay items.]

ITEM 734-U will be paid at 100% of the contract bid price upon completion of the installation of the wood pole.

ITEM 734-W. RELOCATION OF ITS INFRASTRUCTURE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for relocation of ITS equipment, as indicated on the Plans and this Specification, complete and accepted by the Engineer, and shall also include removal, storage, and re-installation of the following: ITS poles and foundations; ITS cabinets (includes all equipment and materials contained within cabinet along with mounting hardware; e.g., network switch, fiber distribution unit, vehicle detection components, and other as noted on plans); ITS cabinet foundation and concrete pads; ITS equipment (e.g., camera, vehicle detection equipment, etc.) along with mounting hardware; or other materials called for on the Plans; and includes all materials, backfill and seeding, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 734-W shall be paid for in accordance with **Section 109** as approved by the Engineer.

ITEM 734-X. REMOVAL OF FIBER OPTIC CABLE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for removal of existing fiber optic cable, as indicated on the Plans and this Specification, complete and accepted by the Engineer, and shall also include removal of the following: commboxes; pull boxes; fiber marker posts; riser assembly (includes riser conduit and mounting hardware); messenger wire, lashing and associated hardware; splice closures; and includes all materials, backfill and seeding, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 734-X. REMOVAL OF ITS INFRASTRUCTURE, measured as noted above, will be paid for at the contract bid price, which shall be full compensation for removal of ITS equipment, as indicated on the Plans and this Specification, complete and accepted by the Engineer, and shall also include removal of the following: ITS poles and foundations; ITS cabinets (includes all equipment and materials contained within cabinet along with mounting hardware; e.g., network switch, fiber distribution unit, vehicle detection components, and other as noted on plans); ITS cabinet foundation and concrete pads; ITS equipment (e.g., camera, vehicle detection equipment, etc.) along with mounting hardware; or other materials called on the Plans; and, include all materials, backfill and seeding, labor, equipment, tools, transportation, and incidentals necessary to complete this item of work.

ITEM 734-X shall be paid for in accordance with **Section 109** as approved by the Engineer.

(b) Payment will be made under Item No.:

734-U Wood Pole – per each
734-W Relocation of ITS Infrastructure (1) – per lump sum
734-X Removal of Fiber Optic Cable (2) – per lump sum
734-X Removal of ITS Infrastructure (1) – per lump sum

(1) Specify Site Identifier or Site Number.
(2) Specify Route [US Route, State Route or Street Name] or Name of Fiber Optic Cable Segment.

SECTION 740
TRAFFIC CONTROL DEVICES FOR CONSTRUCTION WORK ZONES

740.01 Description.

This Section shall cover the work of furnishing, erecting, lighting as directed, handling and maintaining all construction signs (warning, regulatory and guide), barricades and other traffic control devices installed at locations specified by plan details, directed or approved by the Engineer for the purpose of handling traffic safely through construction work zones.

The traffic control devices covered by this Section shall meet the requirements specified in the MUTCD and as detailed on the plans. In case of conflict or discrepancy, the plans shall govern over the MUTCD.

This Section shall also cover the work of furnishing and operating pilot cars and furnishing flaggers to control traffic at such locations and for such periods as are necessary to handle traffic safely through construction work zones.

740.02 Materials.

(a) Approval of Devices.

All signs, barricades, markers, lights and other devices shall be approved for use in highway construction under the provisions of Section 32-5A-36 of the Alabama Code prior to their installation.

The Department has established List IV-3, Work Zone Traffic Control Devices. Devices shown on this list and devices shown on the plans will be the only devices accepted for use. The list is in the Department's manual, "MATERIAL, SOURCES AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS." Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

Portable rumble strips shall be selected from the Department's List IV-4, Miscellaneous Traffic Control Devices. The list is in the Department's manual, "MATERIAL, SOURCES AND DEVICES WITH SPECIAL ACCEPTANCE REQUIREMENTS."

(b) Crashworthiness of Devices.

The Contractor shall be responsible for insuring that all devices that are used for work zone traffic control meet "crashworthy" requirements given in the National Cooperative Highway research Program (NCHRP) Report 350 for the appropriate category of device.

(c) Categories of Devices.

1. Category 1 Devices.

Category 1 Work Zone Devices are small, lightweight devices (including cones, plastic drums, flexible delineators, portable rumble strips, etc.) that are known to be crashworthy either by crash testing or by years of demonstrable safe performance.

2. Category 2 Devices.

Category 2 Work Zone Devices are small, lightweight devices (including barricades, sign supports, etc.) that will not produce significant velocity change when struck but may otherwise be potentially hazardous. All Category 2 devices manufactured or purchased on or after October 1, 2000 shall be crashworthy. All Category 2 devices manufactured or purchased before October 1, 2000 shall not be used after October 1, 2004.

3. Category 3 Devices.

Category 3 Work Zone Devices are truck mounted impact attenuators, work zone impact attenuators, and portable concrete barriers. All impact attenuators shall be crashworthy.

Portable concrete barriers that were fabricated in accordance with the details shown on Sheet 1 of ALDOT Special Drawing PNJB-629 and have "ALDOT 350-TL" cast into the top of the rails are crashworthy and are acceptable for installation.

Other types of portable concrete barrier rails may be used with the written approval of the Construction Engineer.

4. Category 4 Devices.

Category 4 Work Zone Devices are large trailer mounted devices such as sequential arrow boards and changeable message signs. Standards for rating Category 4 devices as "crashworthy" have not been developed.

(d) Materials for Fabrication, Construction, and Installation.

Materials used in the fabrication, construction and installation of the construction signs, barricades and other devices shall conform to the requirements of Article 104.04, plan details, the MUTCD and the details noted in this Section:

Sign panels may be fabricated from one of the types of material shown below:

Material	Min. Panel Thickness	* Sign Face Area
Aluminum Flat Sheets	0.080 inches {2.00 mm}	All sizes
Steel Flat Sheets	0.075 inches {1.90 mm}	All sizes
Plastic Flat Sheets	0.250 inches {6.35 mm}	All sizes
Exterior Plywood Sheets, Grade A-C	0.50 inches {13 mm} 0.75 inches {19 mm}	Up to 16 square feet {1.5 m^2} Over 16 square feet {1.5 m^2}

*NOTE: Any sign panel installation using Standard Mounting procedures, which in the opinion of the Engineer does not provide a reasonably rigid sign installation, shall be strengthened by the use of additional supports and/or backing stringers.

Sign background and messages shall be formed using materials noted for such in Articles 880.02 and 880.03. To permit visual verification of proper use, each type sheeting shall display an identifiable symbol, on the face of the sheeting, in a repeat pattern.

When no pre-requirements are specified for units, they shall comply with the manufacturer's specifications as approved by the Department under the provisions of Section 32-5-36 of the Alabama Code.

Items are not required to be new. Used items may be acceptable provided the following conditions are met:

- Units are in good repair, clean and structurally sound.
- Reflective sheeting on any unit is clean and in good repair.
- All legends and messages are sharp, clean and legible.
- Reflectivity of said units during the hours of darkness shall provide acceptable, clear and uniform delineation without dead spots.

No test reports are required, but the Engineer shall visually inspect all units and accessories for compliance with the various dimensional and material stipulations noted before approving their use in the work. The approval of any unit for use is subject to satisfactory field performance and does not preclude the Engineer ordering replacements of units; said replacements for these previously approved units shall be without additional compensation.

(e) Pilot Car, Flaggers, and Flagging Equipment.

The pilot car, flaggers, and all flagging equipment shall meet the requirements of the MUTCD. The pilot car shall be a registered motor vehicle designed for use upon a highway. "Off-road" type vehicles will not be allowed.

740.03 Construction Requirements.

(a) Traffic Control Personnel, Devices, Equipment and Training.

1. Contractor's Employees Responsible for Traffic Control.

The Contractor shall assign an employee to have the primary responsibility and sufficient authority for the implementation and maintenance of traffic control operations. This employee shall have the responsibility of making modifications to the traffic control that may be necessary because of changing circumstances during construction. The Contractor shall also assign an employee to be available during non-work hours to respond to calls involving the maintenance of traffic control devices. The Contractor shall provide the Department with the contact information in writing for these employees at the preconstruction conference. The Contractor shall also notify the local law enforcement agency in writing with a copy to the Project Manager of the contact information for these employees.

2. Installation of Traffic Control Devices and Equipment.

All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a road under traffic, the necessary signs shall be moved concurrently with the advancing operation.

All construction signs shall be erected in a workmanlike manner such that all supports are vertical, sign panels generally perpendicular to the travelway and legends horizontal so that they effectively convey the intended message. These signs shall be mounted on stationary or temporary supports as directed by the Engineer and dependent on the type work being performed. In general work being performed at spot locations and of short duration will necessitate the use of temporary supports properly ballasted for stability. If the construction signs are not to be lighted, the supports shall not extend above the top edge of the sign panel.

The location, legends, sheeting, dimensions, spacing of supports, and horizontal and vertical placement with respect to the pavement of warning signs, barricades and other traffic control devices shall be as required by plan details, MUTCD and as directed or approved by the Engineer. The Contractor must advise and have the approval of the Engineer prior to installing or removing traffic control devices from the project.

3. Moving and Covering Traffic Control Signs and Other Devices While Not In Use.

During periods when signs and other devices are not being used for traffic control they shall be removed from the work area, covered with the specified material or otherwise positioned so they do not convey their message to the traveling public. If covered, the covering material shall be 1/2 inch {13 mm} (nominal size) exterior plywood cut to fit the shape of the sign panel. The covering material shall be installed in accordance with the plan details and in such manner that no damage will occur to the sign panel during installation. Covering material shall be maintained in a neat and workmanlike manner during its use.

4. Lighting for Traffic Control Signs and Other Devices.

All construction signs, barricades and other devices which require lighting, as designated by plan details or directed by the Engineer, shall be provided with warning lights or electric incandescent or fluorescent lighting. It will be the Contractor's responsibility to install electric lighting in a safe workmanlike manner and in accordance with the latest edition of the National Electrical Code, National Electrical Safety Code and/or all local codes. The Contractor will be responsible for investigating, procuring and bearing the expense of a continuous power source whether by battery, generator or commercial A.C. supply.

5. Flaggers

Flaggers with proper attire and flags shall be provided when ordered by the Engineer or when the Contractor deems flaggers necessary to safely handle traffic through the construction zone. Flaggers are considered a general requirement of all traffic control schemes and no direct payment will be made for such.

6. Engineer's Actions to Address Inadequate Traffic Control.

If the Engineer determines that the proper provisions for safe traffic control are not being provided and maintained by the Contractor the Engineer will order suspension of the work until the proper level is achieved. In cases of serious or willful disregard for safety of the public by the Contractor, the Engineer may restore the traffic control measures to proper condition and deduct all costs of this work from monies due or becoming due the Contractor.

7. Training Requirements.

The Contractor's personnel involved in the implementation, operation, and inspection of traffic control shall be trained appropriate to the decisions each individual is required to make in accordance with 23 CFR 630 Subpart J.

The Contractor's personnel shall have completed the training prior to performing the traffic control work. The Contractor shall furnish a written certification at the preconstruction conference that is worded as follows: “I do hereby certify that all personnel who are involved in the implementation, operation, and inspection of traffic control on the referenced project are trained, or will be trained prior to beginning work, appropriate to the decisions each individual is required to make in accordance with 23 CFR 630 Subpart J”. This wording shall be followed by the signature of an authorized representative of the Contractor.

Employees shall receive periodic training updates that reflect changing industry practices. The Contractor shall maintain records of the training. The records shall include dates of training, name of instructor, name of attendee, length of course, and topics covered. The records shall be available for auditing by the Engineer.

(b) Supplementary Items.

1. Area Lighting.

Area lighting is designated for use at locations where standard delineation devices are not considered sufficient to properly guide the traveling public through the construction work nor advise them of the hazardous conditions which exist. The primary use will be in the areas of crossovers and intersections which are not clearly distinguishable during hours of darkness. Area lighting may consist of one or more area lights.

An area light shall consist of a 250 watt mercury vapor light or equivalent, mounted on a 12 foot {3.6 m} mast arm attached to a Class 7 wood pole of sufficient length to provide a 30 foot {9 m} luminaire mounting height above the elevation of the outside edge of paving, unless otherwise shown by plan details. These lights will be placed at locations designated by the Engineer. If possible, the locations should be such that the lights will adequately light the area, but not present a hazard to the traveling public. Bracing or guying of poles which is unsightly or presents a hazard will not be allowed. It will be the Contractor's responsibility to investigate, procure and bear the expense of the power source for these lights whether by commercial A.C. current or generator and to insure that these light sources are installed in a safe workmanlike manner and in accordance with the latest editions of the National Electrical Code, National Electrical Safety Code and/or all local codes.

2. Special Construction Signs.

Special construction signs shall consist of signs which require special fabricated sign panels or special mounting requirements; such signs will be designated as "Special" on the construction plans.

3. Pilot Car Operation.

Pilot car operation and associated flagging shall be performed as described in the MUTCD. Flagmen and flagging devices are considered a necessary requirement of the pilot car operation and no direct payment will be made for such.

(c) Maintenance.

The Contractor shall assume full responsibility for the continuous and expeditious maintenance of all construction warning signs, barricades and other traffic control devices. Maintenance shall include but shall not be limited to replacement of sign panels, barricades and other devices which in the opinion of the Engineer are damaged or deteriorated beyond effective use, replacement of broken supports, plumbing of leaning signs, cleaning of dirty signs, barricades and other devices, repair of defaced signs, replacement of stolen items, etc.

All items used for traffic control shall be generally maintained in its original placement condition and such maintenance will be considered a part of the original installation cost. Failure to maintain all traffic control devices in such manner as to provide adequate continuous safety to the public will be cause for action by the Engineer as noted in the last paragraph of Subarticle 740.03(a).

(d) Liability.

Reference is made to Section 107 of the Specifications which covers the legal responsibilities of the Contractor to the traveling public. Although the Department will be designating and directing the placement of certain traffic control devices, the Contractor is not relieved of his responsibility to continuously review and maintain all traffic handling measures and insure himself that adequate provisions have been made for the safety of the public and workmen.

Construction signs and other traffic control devices specified by plan details are considered the necessary requirements for satisfactory traffic control. This does not preclude the Engineer from ordering, or the Contractor from requesting for approval, additional signs or traffic control devices to safely handle unforeseen traffic situations, in which case they would be paid for. The Contractor may, with the approval of the Engineer, furnish additional traffic control devices, at no cost to the Department, to protect his work and/or workmen.

740.04 Method of Measurement.

The various items used in the handling of traffic through construction zones will be measured for payment as follows:

Construction Signs and Special Construction Signs which are specified by plan details or ordered by the Engineer and approved for use will be measured in square feet {square meters} computed from measurements of the actual sign panel installed (no deductions will be made for corner radii). The sign supports and mounting hardware are considered incidental to the use of these sign units; hence no separate measurement or payment will be made for the supports and hardware. Measurement for payment under the Item of Special Construction Signs will only be made on signs designated as "Special" by plan details or ordered as "Special" by the Engineer.

Drums will be measured individually for the number ordered and furnished.

Cones will be measured per each and shall be 36 inches {900 mm} high with a ballasted base. Cones of smaller height may be used for operations such as pavement striping and marking, but no direct payment will be made.

Ballasts for cones will be measured per each for each weight {mass} ordered, accepted, and used.

Barricades will be measured individually for the type designated and furnished.

Delineators will be measured per each which includes a 3 inches {75 mm} in diameter reflector of designated color, mounted on a #2 {3 kg/m} steel post or equivalent aluminum post as specified by Part VI of the MUTCD.

Warning lights will be measured per each for the type furnished.

Electrical incandescent or fluorescent lights will be measured individually for each light installed.

Area lights will be measured individually for each light assembly installed.

Vertical panels will be measured per each installation for the number of installations ordered and furnished, which shall include the panel, or panels, post, and hardware. A single-sided installation shall be an installation requiring a panel on only one side of the post. A double-sided installation shall be an installation requiring a panel on each side of the post.

The construction plans may contain traffic handling schemes detailing the signs, barricades and other traffic control devices to be installed at certain locations or in some cases for the entire project. If specified on these traffic handling schemes, and a lump sum pay item is provided, payment shall be made on a Lump Sum basis for all signs and devices detailed on these schemes. Signs, barricades, and other traffic control devices included in this Lump Sum measurement shall meet all requirements as outlined in this Section.

Other traffic control items such as traffic control stripes, legends and markings, portable concrete barriers, sequential chevron and arrow boards and pavement markers when so required will be measured and paid for under the appropriate Section for such provided in the Specifications.

Measurement of Item 740-O, Pilot Car, will be the actual number of units (per Each) ordered and accepted. No direct measurement or payment will be made for a pilot car unless it is listed in the pay items of the contract.

Portable Rumble Strips will be measured per lump sum.

740.05 Basis of Payment.

(a) General.

Payment for Construction Signs and Special Construction Signs measured as noted above will be paid for at the contract unit price bid which shall be full compensation for fabrication of sign panel

with proper sheeting and legend, furnishing and erecting on proper supports, furnishing all mounting hardware, covering when not in use, handling and maintaining until project completion.

Payment for drums, barricades, cones, delineators, warning lights, vertical panels, and ballasts for cones, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for fabrication, erection at designated locations whenever required, furnishing continuous power source for lights, handling and maintenance until project completion.

Electric incandescent or fluorescent lights measured as noted above will be paid for at the contract unit price bid which shall be full compensation for furnishing all materials and mounting hardware, wiring, erecting, maintaining and investigating, procuring and bearing the expense of continuous power supply.

Area Lights measured as noted above will be paid for at the contract unit price bid which shall be full compensation for furnishing all materials and mounting hardware including 250 watt mercury vapor lamp or equivalent luminaire and luminaire mounting arm and Class 7 wood pole, wiring, erecting, maintaining and investigating, procuring and bearing the expense of continuous power supply.

Item 740-O, Pilot Car, measured as noted above will be paid for at the contract unit price bid which shall be full compensation for furnishing and operating the pilot car, for furnishing the pilot car driver and flaggers, for all equipment and materials necessary to complete the work.

Item 740-P, Portable Rumble Strips, measured as noted above will be paid for at the contract unit price bid which shall be full compensation for fabrication, for installation at designated locations whenever required, and for handling and maintenance until project completion.

Payment for Items 740-B - M and 740-P will further include all costs in relocating, removing and returning these Items to the project when required to provide a complete traffic control system throughout the life of the project. No payment will be made beyond the maximum quantity of signs, barricades or other traffic control devices installed at any one time except when alternate sign panels are required for proper handling of the traffic, in such case both alternate panels will be measured for payment.

The Lump Sum payment for traffic control devices specified by plan details shall be full compensation for furnishing all materials, power sources and mounting hardware, erecting, handling, relocating signs and devices within the indicated "Traffic Handling Scheme" and maintaining all traffic control devices until project completion. If traffic control devices are deleted from the traffic handling scheme that is to be paid on a lump sum basis, deductions for the items deleted will be made from the lump sum cost in the amount of the contract unit prices bid for the quantity of individual traffic control items so deleted. Traffic control items which are added to the lump sum traffic handling scheme will be paid for at the contract unit price for the item added. A lump sum payment will be considered as full compensation for "traffic handling scheme". Once construction signs or other warning devices are no longer needed within the designated limits of the lump sum "traffic handling scheme", they may be used in other areas of traffic control and payment will be made under the appropriate pay item.

Unless otherwise designated on the construction plans, all signs, barricades, and other traffic control devices covered by this Section shall become the property of the Contractor at the completion of the project. The salvage value for these items shall be reflected in the contract unit prices bid.

No payment will be made for stored materials under this Section unless the material in storage was either manufactured or purchased new for specific use on the project.

No payment will be made for devices installed solely for the protection of the Contractor's work and which serve no useful purpose in protecting the safety of the public or workmen such as traffic cones for paint protection, devices installed to protect fresh concrete presenting no hazard, etc.

The Contractor will be expected to submit a balanced bid for all traffic control items. The submission of unbalanced bid prices may result in loss of contract award.

(b) Payment will be made under Item No.:

740-A Traffic Control Scheme - per lump sum
740-B Construction Signs - per square foot {square meter}
740-C Special Construction Signs - per square foot {square meter}
740-D Channelizing Drums - per each
740-E Cones (36 inches {900 mm} high) - per each
740-F Barricades, Type ____ - per each
740-G Barricades, Type I, (Portable, 24 inches {600 mm} wide) - per each
740-H Delineators - per each
740-I Warning Lights, Type ____ - per each

740-J Electric Incandescent or Fluorescent Light - per each
740-K Area Light - per each
740-L Vertical Panel Type ___* , ___** Sided – per Each
740-M Ballast for Cone - per each
740-O Pilot Car - per each
740-P Portable Rumble Strips - per lump sum

* Specify either I or II
** Specify either Single or Double

SECTION 741
PORTABLE SEQUENTIAL ARROW AND CHEVRON SIGN UNIT

741.01 Description.

This Section shall cover the work of furnishing Portable Sequential Arrow and Chevron Sign Units and all services and operational supplies necessary to provide a functional sign unit during the life of the contract.

Three categories of furnishing and use of these type sign units are covered by this Section. These categories are as follows:

Pay Item 741-A - The furnishing of a new sign unit, its use during the contract, its re-conditioning and title transfer to the Department upon completion of the project.

Pay Item 741-B - The use of Department furnished units during the contract, the re-conditioning of the unit after completion of the project and its return to the Department's storage yard.

Pay Item 741-C - The furnishing and use of units during the contract with the title remaining with the Contractor.

741.02 Materials.

(a) Item 741-A.

All sign units furnished by the Contractor for use under this Item shall be listed on List IV-3, WORK ZONE TRAFFIC CONTROL DEVICES, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

All sign units furnished for use under this Item shall be new units which include all of the latest modifications to manufacturers current production models. Each sign unit shall be self contained and include message board, power supply and trailer.

(b) Item 741-B.

These units will generally meet the requirements of Subarticle (a) above and will be made available to the Contractor by the Alabama Department of Transportation for use during the course of the project. These units will have automatic dimming of lamp intensity for day and/or night operation. Operation manuals for these units will be furnished.

(c) Item 741-C.

All sign units furnished for use under this Item may be new or reconditioned units which were designed and manufactured specifically for use in traffic control which provide at least the following:

1. A minimum 4 foot x 7.8 foot {1.2 m x 2.4 m} message board of an appropriate design capable of producing a left or right hand mode for a sequential chevron (min. of 3 chevrons), flashing arrow, sequential arrow or sequential stem arrow using 5 inch {125 mm} diameter sealed beam lamps.
2. Electronic controls for operating messages at 30-50 FPM with automatic dimming of lamp intensity for day and/or night operation capability.
3. Power source shall be capable of providing an adequate continuous power supply for at least 24 hours without refueling.
4. A trailer of substantial design for transporting the sign unit from one location to another and to provide a stable setup at location of use.

741.03 Construction Requirements.

(a) General.

The portable sign unit furnished or provided under this Section is to be used in conjunction with the handling of traffic through the work. The use thereof is shown on the plan details for traffic handling.

(b) Maintenance.

All sign units shall be maintained in such a manner as to provide continuous service during their use on the project. Units which become nonoperational during use will require the Contractor to provide flagmen or other approved traffic handling methods until the units can be repaired or replaced.

In addition to the above the maintenance of units furnished by the Alabama Department of Transportation or which are to become the property of the Alabama Department of Transportation upon project completion shall include the following:

1. The sign units shall be stored in an approved secured storage area when not in use.
2. The Contractor will be required to perform all maintenance operations recommended by the manufacturer of the units keeping adequate records of such operation. The units shall be kept in good repair at all times. This includes cleaning of the unit and maintenance of the exposed protective coatings on the unit.

(c) Return or Transfer of Title to the Department.

Prior to completion of the project and when the units are deemed of no further use in handling of traffic, each unit shall be cleaned, checked and repaired as necessary to place the unit in good operation condition prior to transfer of title or return of the unit to the Department.

After inspection by Departmental personnel and the units are found to be in good operational condition with all working parts functioning, the units along with a copy of the unit's operating manual, maintenance records and title transfer, if required, shall be delivered to the designated Department storage yard.

741.04 Method of Measurement.

Measurement of Sign Units will be made in complete functional units.

741.05 Basis of Payment.

(a) Unit Price Coverage.

1. Item 741-A.

The ordered and accepted sign units under this Item, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the furnishing of a new sign unit and its exclusive use on the project, for providing all equipment, supplies, services, labor and incidentals necessary to operate and to maintain the units in good serviceable condition during the life of the contract, for transporting of the units as necessary, and upon completion of the project, the reconditioning of the units and the transfer of title of the unit to the Department along with its service records and operating manuals.

2. Item 741-B.

The ordered and accepted sign units under this Item, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the handling of the unit, for providing all equipment, supplies, services, labor and incidentals necessary to operate and to maintain the units in a good serviceable condition during the life of the contract and upon completion of the project the reconditioning of the unit to the same condition they were in upon their receipt and the return of the unit, its service records and operating manuals to the Department's storage facility.

3. Item 741-C.

The ordered and accepted sign units under this Item, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for the furnishing of acceptable new or reconditioned sign units and its exclusive use during the life of the contract, for the handling of the unit and for providing all equipment, supplies, services, tools, labor and incidentals necessary to operate and to maintain the units in a good serviceable condition during the life of the contract.

(b) Payment will be made under Item No.:

741-A State Retained Portable Sequential Arrow and Chevron Sign Unit - per each

741-B State Furnished Portable Sequential Arrow and Chevron Sign Unit - per each
741-C Portable Sequential Arrow and Chevron Sign Unit - per each

SECTION 742
PORTABLE CHANGEABLE MESSAGE SIGNS

742.01 Description.

This section shall cover the work of furnishing new portable changeable message signs or utilizing State furnished portable changeable message signs. The furnishing of new signs includes all services and operational supplies necessary to provide a functional sign unit. All changeable message signs shall be in compliance with the current edition of the MUTCD (Manual on Uniform Traffic Control Devices).

742.02 Materials.

(a) General.

All changeable message signs shall be designated according to "Type" with a Type 1 having a one-line message display panel, a Type 2 having a three-line message display panel, and a Type 3 having a Full Matrix display panel. If ownership of the sign is to be retained by the State and the sign is vehicle mounted, the sign unit shall be suitably adaptable, including all connections, for mounting onto a standard size 1/2-ton pickup truck. The sign framework and installation shall be structurally adequate to allow complete sign operation, including raising and lowering the sign panel at sustained highway speeds of 62.5 miles per hour {100 km per hour}.

(b) Type 1 Message Sign.

A Type 1 sign shall be a portable, one-line, changeable message sign suitable for mounting on either a truck or on a two-wheeled trailer. The sign system shall consist of a single line sign panel assembly, controller, power supply, structural support system, all applicable software, and manuals.

(c) Type 2 Message Sign.

A Type 2 sign shall be a portable, three-line, changeable message sign mounted on a two-wheeled trailer. The sign system shall consist of a three-line sign panel assembly, controller, power supply, and structural support system, all mounted on a two-wheeled trailer. The sign unit shall be furnished with all necessary cabling, software and manuals.

(d) Type 3 Message Sign.

A Type 3 sign shall be a portable, full matrix (variable letter, graphic, and symbols), changeable message sign. The system shall consist of a full matrix sign panel assembly capable of producing an inverse display with a programmable controller capable of displaying standard traffic safety and custom symbols. The sign and power plant shall be trailer mounted. The sign shall be furnished with all necessary cabling, software, and manuals.

742.03 Construction Requirements.

(a) General.

The Contractor shall utilize to the fullest extent the Changeable Message Sign whenever any potential hazardous condition exists that would require extra emphasis in warning the driver of any emergencies that might arise during the construction, or at any location directed by the Engineer. Any message used on the sign shall be approved by the Engineer.

(b) Pay Item 742-A.

The Contractor shall furnish a new or used sign unit, and shall be totally responsible for the required performance of the sign.

An acceptable sign unit shall be one of the units listed on List IV-3, WORK ZONE TRAFFIC CONTROL DEVICES, Sub-Heading "Message Signs" of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" manual. Information concerning this list can also be found in Sub-article 106.01(f).

The Contractor shall retain ownership of the sign unit when the Engineer determines that the sign is no longer needed.

(c) Pay Item 742-B.

The Contractor shall furnish a new and fully functional sign unit. An acceptable sign unit shall be one of the units listed on List IV-3, WORK ZONE TRAFFIC CONTROL DEVICES, Sub-Heading "Message Signs" of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" manual.

When the Engineer determines that the sign unit is no longer needed, ownership shall be transferred to the Department.

(d) Pay Item 742-C.

The Contractor shall use a Department furnished sign unit. The Contractor shall clean, service and repair the sign unit when the Engineer determines that the sign unit is no longer needed, and shall return the sign unit to the Department and transfer the title of the unit to the Department.

742.04 Maintenance Requirements.

The sign unit shall be kept in good repair at all times. Failure, malfunction or damage to the unit for any reason shall require the Contractor to expedite the repair, or replacement, and furnish adequate flagmen or other approved means, at his expense, to provide a safe means for the control of traffic until the unit is put back into service. Maintenance shall include the periodic cleaning of the unit along with the repair of damage to the protective coating of the unit.

Sign units furnished under Pay Items 742-B (Contractor furnished) and 742-C (State furnished) shall be stored in an approved, secure storage area when not in use. The Contractor shall perform all maintenance operations recommended by the manufacturer of the sign and keep complete records of this maintenance.

742.05 Delivery of Unit and Transfer of Title, Pay Items 742-B and 742-C.

Prior to the completion of the project, and when the Engineer determines that the sign unit is no longer needed, the Contractor shall clean and service the unit to insure that the unit is in good operational condition. After Departmental personnel inspect the sign unit and find it to be in good operational condition with all working parts functioning, the unit, along with a copy of the unit's operating manual, maintenance records and title transfer (title transfer required under Pay Item 742-B), shall be delivered to the location designated by the Engineer.

742.06 Method of Measurement.

Measurement of Portable Changeable Message Signs will be by complete individual sign units for the type sign furnished.

There will be no overrun of this item without written permission of the Construction Engineer.

742.07 Basis of Payment.

(a) Unit Price Coverage.

The ordered and accepted sign units, measured as noted above, will be paid for at the contract unit prices which shall be full compensation for fabricating and furnishing the unit to the project, if required, for the exclusive use during the project, for maintenance and operation of the unit during the life of the contract, and includes all equipment, tools, labor, services, supplies, and incidentals necessary to complete this item of work.

The contract price for Pay Items 742-A and 742-B shall also include the reconditioning of the unit, transfer of the title of the unit, if required, and delivery to the designated storage location.

(b) Payment will be made under Item No.:

742-A Portable Changeable Message Signs, Type ____ - per Each
742-B State Retained Portable Changeable Message Signs, Type ____ - per Each
742-C State Furnished Portable Changeable Message Signs, Type ____ - per Each

SECTION 745
UNIFORMED POLICE OFFICERS

745.01 Description.

This Section shall cover the work of furnishing Uniformed Police Officers to assist in directing traffic through work zones. Officers furnished and paid for under this Section will be allowed only at the

direction of, or with the approval of, the Engineer. The officers shall be employed by and paid by the Contractor.

745.02 Qualifications and Training.

Officers furnished under this Section shall be employees of the law enforcement agency having jurisdiction over the location where they are performing the duties covered by this Section. Officers shall have arrest powers for the location in which they are working and shall wear their complete police uniform while working. Officers shall abide by the Department's GFO 1-5 regarding personal protective equipment.

Officers shall use a publicly owned marked vehicle. The vehicle shall have adequate front and rear lighting with emergency lighting that is visible for at least 500 feet.

Officers shall be trained in accordance with the requirements given in 23 CFR 630 Subpart J. Any course meeting the requirements of 23 CFR 630 Subpart J will be acceptable. A DVD copy of one such course, "Alabama Law Enforcement Agency Construction Zone Safety Training", may be obtained by contacting the Project Manager. Other courses may also be available through the ATSSA (American Traffic Safety Services Association).

Officers shall certify in writing prior to the officer beginning work that they have completed the training. The certification shall read as follows: "I do hereby certify that I have completed training appropriate to the job decisions I am required to make in accordance with the requirements given in 23 CFR 630 Subpart J.". This wording shall be followed by the officer's signature. The Contractor shall provide a copy of this certification to the Project Manager prior to the officer beginning work.

745.03 Duties.

The duties of police officers under this Section shall consist of assisting in the directing of public traffic through construction work zones and the enforcement of traffic laws. This shall be done at such locations and for such periods as deemed necessary and appropriate by the Engineer for the control and protection of vehicular and pedestrian traffic in accordance with the MUTCD.

745.04 Method of Measurement.

The item of Uniformed Police Officer measured for payment will be the number of hours this item was ordered and acceptably performed. The number of hours measured for payment will be the total number of hours for each officer performing work under this item.

745.05 Basis of Payment.

(a) Unit Price Coverage.

The number of hours this item of work was ordered and acceptably performed, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for furnishing all personnel, materials, labor, equipment, tools and incidentals necessary to complete this item of work.

Payment will not be made for an officer for whom the Contractor has not submitted the signed statement certifying that the officer has completed the required training.

(b) Payment will be made under Item No.:

745-A Uniformed Police Officer - per hour

SECTION 750
ROADWAY LIGHTING

750.01 Description.

This work shall consist of furnishing and installing roadway lighting systems, or the modification of roadway lighting.

The structural requirements (design and materials) for roadway lighting are addressed in Section 718.

750.02 Materials.

Materials shall meet the requirements given in Section 889.

Prior to purchasing materials, and within 30 days after the issuance of the "Notice to Proceed", the Contractor shall submit seven copies of a complete descriptive list of all materials (wiring, conduits, boxes, mounting hardware, power control devices, luminaires, luminaire poles, etc.) to the Engineer for

approval. (The requirement for the submittal of structural designs and details is given in Section 718.) This information shall be submitted on the Department's Material Submittal Form furnished to the Contractor for this purpose. The submittal shall also include seven copies of "catalog cutouts" or published data sheets for each item on the list. Incomplete or inaccurate submittals will be returned to the Contractor for revision and resubmittal. Partial lists may be considered if prior approval for the submittal of a partial list is approved in writing by the Engineer.

Materials shall not be installed prior to approval. The Department will not be liable for materials purchased, work performed, or any delay incurred due to the failure of the Contractor to secure prior approval.

Failure of the Engineer to note unsatisfactory material as received at the job site will not relieve the Contractor of the responsibility of furnishing the required material.

750.03 Construction Requirements.

(a) Code.

All work shall be done in accordance with the requirements given in the current edition of the National Fire Protection Association "NFPA 70, "National Electrical Code" (NEC) and the regulations and standards of the power company providing service.

(b) License.

The Contractor responsible for the performance of the work shall be licensed as a General Contractor authorized to perform electrical work by the Alabama State Licensing Board for General Contractors

At least one out of every three persons in each work crew shall be a Journeyman licensed by the Alabama Electrical Contractors Board. Journeymen shall be present and shall have direct involvement with all work required for the installation and operational testing of electrical materials and equipment. The Journeymen shall also possess an IMSA (International Municipal Signal Association) Roadway Lighting Level 1 Certification.

The Contractor shall submit copies of the General Contractor license, Journeyman licenses and IMSA certifications to the Engineer as a part of the submittal of the list of materials proposed for installation. Work shall not begin on the installation of electrical materials or equipment until copies of the licenses and certifications have been approved by the Engineer.

(c) Electrical Power.

The entity (City, County, State, etc.) that will be responsible for the eventual operation and maintenance of the roadway lighting system will make application for electrical service upon notification that power service will be required. The Contractor shall inform the Engineer when power service is required at least 30 calendar days prior to the need of the power service. This same entity will be responsible for the cost of the service connection and the monthly service billings thereafter.

Electrical power shall be the power system shown on the plans which will usually be a single phase, 3-wire, 480 Volt-AC system. Power shall be provided by a transformer that does not provide power to any other equipment.

(d) General Conduit System Installation Requirements.

Conduit shall be installed in accordance with the details shown on the plans or as directed by the Engineer. Rigid Nonmetallic Conduit (RNC) may be installed as a substitute for Nonmetallic Underground Conduit with Conductors (NUCC) if it is the same size and schedule as the NUCC. Conduit routing shown on the plans is diagrammatic only. Actual routing shall be in the most prudent manner as approved by the Engineer.

Underground conduit depth shall be 24 inches {600 mm}, minimum, unless shown otherwise on the plans.

All conduit ends (except NUCC and HDPE) shall be put together in couplings to form a smooth raceway for cables. Bushings and duct sealant shall be installed at all conduit terminations to protect the insulation of the conductors and to prevent debris from entering the conduit. Conduits shall be joined by approved methods prescribed by the manufacturer of the conduit. When conduit is installed for future use, the ends of the conduit shall be capped with a fitting listed for this purpose to prevent water and other foreign matter from entering the conduit system.

The Contractor shall seed and mulch disturbed areas as directed by the Engineer. The seeding and mulching of disturbed areas shall be a subsidiary obligation of the conduit installation.

Before beginning excavation, the Contractor shall determine the location of all utilities in the vicinity. Utilities shall not be damaged during construction.

Conduit shall be located to avoid potential conflict with the future installation of guardrail, signposts, and other equipment and devices. A minimum of 12 inches {300 mm} clearance shall be provided between the finished lines of conduit runs and existing underground utilities. Where the underground conduit run is adjacent to concrete walls, piers, footings, etc., a minimum of 4 inches {100 mm} of undisturbed earth or firmly compacted soil shall be maintained between the conduit and the adjacent concrete.

Unless shown otherwise on the plans, trenches shall not be excavated in existing pavement or paved shoulders to install conduit. When it is necessary to place conduit under an existing pavement, the conduit shall be installed in accordance with the requirements given in Section 756. Unless approved otherwise by the Engineer, trenches shall not remain open after normal work hours each day.

Liquid Tight Flexible Metal Conduit (LFMC) or Liquid Tight Flexible Non-metallic Conduit (LFNC) as shown on the plans or directed by the Engineer shall be installed where conduits cross an expansion or open joint on bridges, barrier rails or structure. The LFMC or LFNC shall be 36 inches {900 mm} in length and shall have a sag of not more than 3 inches {75 mm} between the fixed ends of the rigid conduit.

(e) Junction Boxes.

The types of junction box shall be:

TYPE	INSTALLATION LOCATION	BOX MATERIAL
Type 1	Installed flush with grade.	Non-Metallic
Type 2	Installed on the surface of a structure.	Metal
Type 3	Installed flush with surface of a structure.	Non-Metallic
Type 4	As Shown on the Plans	As Shown on the Plans

(f) Nonmetallic Underground Conduit with Conductors.

Nonmetallic Underground Conduit with Conductors (NUCC) shall be installed in accordance with the manufacturer's recommendations.

If plowing is proposed for the installation of the NUCC, the manufacturer’s recommended installation practices shall be submitted to the Engineer prior to beginning the installation. If the Engineer is not satisfied with the Contractor’s performance and knowledge once installation begins, the Contractor shall arrange for a manufacturer’s representative experienced in plowing methods to be at the jobsite until the Engineer determines that the Contractor is capable of properly installing the NUCC. If rock or other obstructions hinder plowing operations, the Engineer may require that conductor routes be pre-ripped to locate rock or hidden obstructions. Obstructions may be removed or the conductors routed around them as approved by the Engineer.

If the "Plow Pulling" method is used, the plow operator shall have an acceptable method to insure that the manufacturer’s recommended maximum tensile force on the NUCC is not exceeded.

If at any time the Engineer determines the installation is not in full compliance with the intent of the manufacturer’s recommended practices, the operation shall stop until a manufacturer’s representative can further instruct the Contractor’s personnel in the deficient areas.

If the "Chute Plowing" method is used, special attention shall be given to the conductor feed chute dimensions.

(g) Conductor Installation.

1. Splices and Taps in Conductors.

Splices and taps in conductors shall only be made in junction boxes and pole bases. They shall be made with solderless split bolt connectors.

Splices and taps shall be protected in sealed in silicone gel filled enclosures to provide a waterproof connection and to ensure the required electrical insulation.

Silicone gel filled enclosures shall be re-enterable; shall be UV resistant, listed for temperatures from -40 °C to 90 °C; and shall be impact and abrasion resistant. The enclosure shall be sized as shown in the following table:

Conductor Size	Gel Enclosure Size
#4 AWG and smaller	#2
#2 AWG	#2.5 or Miniwedge
Larger than #2 AWG	#3

2. Pulling Conductors into Conduit.

Conductors shall not be pulled into a conduit until the installation of the conduit is complete. Conductors in conduits shall be carefully pulled into place using approved methods so that the

conductors will not be damaged. Powdered soapstone, talc, or other inert lubricant specifically designed for the purpose shall be used when pulling conductors through the conduit. All conductors within a single conduit shall be pulled at the same time and shall be handled and installed in such a manner as to prevent kinks, bends or other distortion which could damage the conductor and outer covering. When conductors are pulled through hand holes, pole shafts, etc., a pad of firm rubber or other suitable materials shall be placed between the conductors and the edges of the opening to prevent damage to the conductors.

(h) Grounding.

All metal poles and metal enclosures containing electric wires and/or equipment shall be grounded. Exothermic welds or other approved connectors shall be used to connect the grounding conductor to the ground rods.

A continuous grounding conductor, either bare or having a green colored insulation, shall be extended from the service ground to all equipment and shall be used for grounding purposes only.

(i) Lightning Protection.

Lightning protection shall be installed as shown on the plans at all poles greater than or equal to 75 feet {22.8 m} in height.

(j) Foundations.

For bidding purposes, the size and configuration of reinforced concrete foundations will be shown on the plans for the designated ranges of pole heights

The Engineer will inform the Contractor if changes are required to the depth of concrete foundation required at each pole. Changes in the depth of foundations may be made based on a review the Contractor's design submittal. The Contractor will be notified of any such changes upon completion of this review. If no changes are required, the Contractor shall install the as-bid sizes of foundations.

Care shall be taken to properly orient the anchor bolts of concrete foundations so that the luminaire assembly will be in proper alignment with the roadway.

Conduits shall be accurately placed, oriented in the proper direction to accommodate future extension, and securely held in place to prevent movement.

Concrete shall then be placed in the excavated area against undisturbed earth below the finished ground line. The concrete shall be placed in an approved form above ground line to the top of the foundation. All exposed edges of the concrete shall have a 3/4 inch {19 mm} chamfer.

The top of the foundation shall be level and shall be placed to properly orient the luminaire assembly with the roadway. For breakaway poles, the finished foundation shall have a maximum 4 inch {100 mm} "Breakaway Support Stub Height Measurement" as defined in the AASHTO Roadside Design Guide, Chapter 4.2.

(k) Installation of Luminaire Poles.

Luminaire poles shall be installed in a vertical position. Erection shall be accomplished carefully to prevent marring the finish or otherwise damaging the pole.

When lighting is to be installed on a bridge, the Contractor shall, before ordering the poles, examine the bridge plans or the completed bridge, whichever is applicable, to determine the exact nature of the proposed or existing details which will accommodate the luminaire poles. Any discrepancies between the plans and an existing bridge structure shall be immediately reported to the Engineer.

The Contractor shall verify that the pole anchor bolts, base plate bolt pattern, and pole assembly (including tenon mounting holes, multiple pole sections, and hand-hole orientation) are coordinated for proper orientation of lowering devices and luminaires to the roadway as shown on the plans.

A screen made from 1/4 inch {6.4 mm} mesh galvanized wire cloth shall be fabricated and inserted in the pole base to prevent rodents, etc. from entering the pole.

Backfill for direct burial fiberglass poles shall be as recommended by the pole manufacturer.

Care shall be taken to assure the bracket arm is properly aligned.

(l) Installation of Luminaires.

The light control surfaces and glassware shall be cleaned after installation. Cleaning shall be performed in accordance with the luminaire manufacturer’s recommendations. Luminaires shall be leveled, plumbed, and installed as per the manufacturer’s recommendations to achieve the most suitable light pattern.

The Contractor shall verify that the lamp socket is in the proper position to produce the optimum lighting pattern for each luminaire not to just meet minimum. Each luminaire shall be adjusted to provide the most effective light pattern as directed by the Engineer after installation.

(m) Testing Insulation.

The insulation of all lighting circuits will be tested by the Engineer at the load side of the contactors or circuit breakers. These tests shall be made with a 500-volt DC Megger Tester. Any reading of 250,000 ohms to ground or higher is satisfactory. Any reading of less than 250,000 ohms to ground is unacceptable and shall be corrected. The Engineer may conduct additional insulation testing after the completion of the operational testing.

(n) Ground Resistance Testing.

The resistance to ground will be tested by the Engineer at each lighting control center . The test will be conducted using a null balance earth tester with auxiliary ground rods placed 50 feet {15.24 m} and 100 feet {30.48 m}, respectively, from the tested ground rod. A reading of 25 ohms or less is satisfactory. Any reading over 25 ohms will require the installation of additional ground rods to be placed in a pattern as directed by the Engineer. The Engineer may conduct additional ground resistance testing after the completion of the operational testing.

(o) Testing Luminaire Lowering Devices.

The Contractor shall perform a functional test on all luminaire lowering devices. Tests shall be performed in the presence of the Engineer. The test shall be performed on the final completed lighting assembly with all luminaires and other components installed. The test shall be performed as follows:

- Start with the device in the latched position on top of the pole.
- Unlatch and lower the device support to ground level for inspection.
- Raise device to top and latch.
- Unlatch and lower the device 5 to 10 feet {1.53 to 3.05 m}.
- Raise the device and confirm that secure latching has occurred.
- Repeat unlatching, lowering, raising and latching three times.

If latching or unlatching failures occur, or if any other problems occur during the test, the Contractor shall make corrections and repeat the complete test in the presence of the Engineer.

(p) Operational Testing of the System.

The Contractor shall perform full operational testing of the completed lighting system after the completion of the installation of all equipment and materials, including all miscellaneous items of work required for the complete lighting system. The operational testing will not begin until the testing of the insulation, resistance to ground, and luminaire lowering devices has been completed and accepted by the Engineer.

The Engineer will set the date that the operational testing will begin. The Contractor shall provide all installation and operational instructions for all lowering devices before the operational testing of the system will be allowed to begin.

An operational test shall be the full operation of all components of the lighting system for a period of 30 calendar days. During this test period the Contractor shall perform all necessary adjustments (including re-aiming of luminaires) and replace all malfunctioning parts of the equipment required to place the system in a fully operational condition. Extra compensation will not be given for adjustments, maintenance, repairs and replacements during the test period. The initial test period will be suspended as directed by the Engineer during the time that the entire lighting system is not in full operation. The 30 calendar day operational test period shall be restarted or repeated if required by the Engineer due to repeated failure of the lighting system.

The Engineer will perform a final inspection of the lighting system at the completion of the operational testing. If all items of work in the contract have been completed, the Engineer will suspend contract time charges during the operational testing.

Upon completion of the operational testing, field tests may be conducted by the Engineer to verify that the required lighting levels and uniformity ratios are being provided. Any adjustments to the lighting system necessary to meet the design criteria shall be done at the Contractor’s expense.

(q) Warranties, Guarantee and Maintenance.

The State shall be protected from any defect in the lighting system by the following:

- The Contractor shall provide the manufacturer’s warranties to the State for all electrical and mechanical equipment.

- The Contractor warrants equipment and guarantees workmanship for satisfactory in-service operation of the electrical and mechanical equipment and related components for a period of one year following the date of completion of the operational check period.
- Maintenance repair work may be required for long duration contracts. In the case of long duration contracts the Contractor shall perform maintenance repair work on the lighting system (equipment, devices, structures and hardware) from the end of the one year warranty period until the end of contract time charges. Maintenance repair work during this time period will be paid for as "Extra Work" in accordance with the requirements given in Article 109.04.

The Department will not make the final payment for work under this Section until the warranties, guaranties and contact information are furnished to the Engineer.

(r) Modification of Roadway Lighting.

The modification of roadway lighting shall consist of any amount of preparation, restoration, relocation, rehabilitation, demolition or salvage work designated on the plans for modification. New materials shall be furnished when required for the modification work unless noted otherwise on the plans.

(s) Lump Sum Roadway Lighting.

The work of furnishing and installing "lump sum" Roadway Lighting shall consist of the construction of partial or complete roadway lighting as shown to be required on the plans. It may be work that is limited to no more than the installation of lamps or fuses for luminaires to a complete roadway lighting system with multiple lighting structures, luminaires and lighting control equipment.

750.04 Method of Measurement.

Pay Items 750-A, B, C, D, H, I, and L will be measured per each item.

Pay Items 750-E, F and G will be measured in linear feet {meters}.

Pay Items 750-J, K and Z will be measured as lump sum units.

750.05 Basis of Payment.

(a) Unit Price Coverage.

The contract unit price for each Pay Item shall be full compensation for all materials, tools, labor, equipment and miscellaneous items required to compete the item of work. This will include excavation, foundations, conduits, conductors, pole assemblies, luminaires, junction boxes, lighting control centers, power service equipment and materials as designated for each pay item.

Pay Items are as follows:

1. Item 750-A: High Mast Luminaire Assembly.

A high mast luminaire assembly shall be the pole, lowering device, electric motor, pole wiring system, luminaires, lamps, fuses, circuit breaker, surge arrester, lightning protection system, pole numbers, equipment grounding system, and miscellaneous hardware.

2. Item 750-B: Roadway Luminaire Assembly.

A roadway luminaire assembly shall be the pole, pole numbers, pole wiring system (State furnished when applicable), surge arrester, lightning protection system, Type 1 junction box, equipment and pole grounding systems, fuses, luminaires, lamps, and miscellaneous hardware. A breakaway device and luminaire lowering device shall be a part of this pay item when shown to be required on the plans. When a luminaire assembly is shown on the plans to be a breakaway assembly, the State will furnish pole wiring system which includes a surge arrestor.

3. Item 750-C: Pole Foundation.

A pole foundation shall be a reinforced concrete foundation including the excavation, disposal of excavated material, concrete, backfill, concrete pad, reinforcing steel, conduit and elbows, anchor bolts, and mulching and seeding the disturbed ground.

The compensation for a reinforced concrete foundation may be adjusted if the size of the foundation is required to be changed. Bid prices shall be given for the construction of a foundation to the depth and at the diameter shown on the plans. A deeper foundation may be required based on the results of the Department's review of the Contractor's submittal of the design of the pole structure.

The compensation for a foundation will be adjusted if changes are required to be made to the depth of the foundation. The adjustments shall be in accordance with the following requirements:

- 2'-0" {600 mm} Diameter: The compensation for 2'-0" {600 mm} diameter foundation shall be increased by $50 for each foot {$50.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.
- 2'-6" {760 mm} Diameter: The compensation for 2'-6" {760 mm} diameter foundation shall be increased by $75 for each foot {$75.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.
- 3'-0" {910 mm} Diameter: The compensation for 3'-0" {910 mm} diameter foundation shall be increased by $100 for each foot {$100.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.
- 4'-0" {1.22 m} Diameter: The compensation for 4"-0" {1.22 m} diameter foundation shall be increased by $200 for each foot {$200.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.
- Reinforcing Steel: The adjustments to compensation because of changes in foundation depth shall also cover compensation for providing the reinforcing steel shown on the plans for the deeper foundations. The number and size of longitudinal reinforcing steel and the size and spacing of hoops will be the same regardless of any change in depth.

4. Item 750-D: Electrical Junction Box.

An electrical junction box shall be the junction box, concrete, and mounting hardware.

5. Item 750-E: Conduit.

Conduit (RMC, LFMC, LFNC, or RNC) shall be the conduit tubing including fittings, trenching, backfilling, attachment to structure and miscellaneous hardware.

6. Item 750-F: Conductor.

This shall be individual conductors and includes pulling, splicing, terminating, testing and miscellaneous hardware.

7. Item 750-G: Combined Duct and Conductors:

Combined duct and conductors (NUCC) shall be the complete assembly of polyethylene duct and the size and number of required conductors. It shall include fittings, trenching, backfilling, splicing, terminating, testing and all miscellaneous hardware.

8. Item 750-H: Service Pole.

A service pole shall consist of the pole, switch, fuses, ground rod, one-spool clevis, down guy and guy rod (if required) and miscellaneous hardware.

9. Item 750-I: Lighting Control Center.

A lighting control center shall include switches, circuit breakers, contactors, fuses, enclosures, photocontrols, ground rods, incoming service conductors and conduit, concrete slab, anchor bolts, and miscellaneous hardware.

10. Item 750-J: Preparation Work for Utility Company Equipment.

This work shall include the installation of concrete pads, pull boxes, conduit, grounding equipment, conductor vaults, and other equipment and materials as shown on the plans.

11. Item 750-K: Modification of Roadway Lighting.

The modification of roadway lighting shall consist of the work shown on the plans to be included in this pay item. It may include any kind and amount of preparation, restoration, relocation, rehabilitation, demolition and salvage work detailed on the plans.

12. Item 750-L: Landscape Luminaire Assembly.

Landscape luminaire assemblies shall be furnished and installed by the Contractor in accordance with the details shown on the plans. Each landscape luminaire shall be connected to the electrical power service to become a fully functional part of the required lighting system.

13. Item 750-Z: Roadway Lighting.

Roadway Lighting (lump sum) shall include all equipment, materials, tools, labor, and miscellaneous items required for roadway lighting as shown to be required on the plans. This shall include all excavation, foundations, conduits, conductors, pole assemblies, luminaires, junction boxes, lighting control centers, power service equipment and materials, and all miscellaneous items required to complete the work shown on the plans that is included in this item of work.

(b) Payment will be made under Item No.:

750-A High Mast Luminaire Assembly with _*_ - per each
750-B Roadway Luminaire Assembly with _*_ - per each

750-C Pole Foundation, __**__ - per each
750-D Electrical Junction Box, Type ____ - per each
750-E Conduit, __***__ - per linear foot {meter}
750-F Conductor, __****__ - per linear foot {meter}
750-G Combined Duct and Conductors, __*****__ - per linear foot {meter}
750-H Service Pole - per each
750-I Lighting Control Center - per each
750-J Preparation Work for Utility Company Equipment - per lump sum
750-K Modification of Roadway Lighting - per lump sum
750-L Landscape Luminaire Assembly, __******__ - per each
750-Z Roadway Lighting - per lump sum

* number, type, and wattage of luminaire(s) as required
** either Roadway or High Mast
*** conduit size and type
**** size of conductors
***** number and size of conductors
****** either bollard, canopy, recessed light, up light or down light

SECTION 751
REHABILITATION OF EXISTING ROADWAY LIGHTING

751.01 Description.

This work shall consist of rehabilitating existing roadway lighting systems to the extent indicated on the plans. All work shall be performed with the requirements of Section 750 and as shown on the plans.

The structural requirements (design and materials) for roadway lighting are addressed in Section 718.

751.02 Materials.

All material requirements given in Article 750.02, including submittals, shall apply to the rehabilitation work unless noted otherwise on the plans.

751.03 Construction Requirements.

The requirements for the rehabilitation of a roadway lighting system will be shown on the plans. All of the construction requirements given in Article 750.03, including the requirements for submittals, testing, and guarantees, shall be applicable to the rehabilitation work unless noted otherwise on the plans.

751.04 Method of Measurement.

All rehabilitation of existing roadway lighting system items with the exception of 751-M will be measured per each by the appropriate items complete, in place, acceptably installed and operational. For Pay Item 751-C, Testing Circuit Insulation, each circuit shall be separate and be measured per each. Pay Item 751-M will be measured per lump sum.

751.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted rehabilitation of existing roadway lighting, measured as noted above, will be paid for at the contract unit price bid. This price will be full compensation for furnishing all materials, installation, labor, equipment, tools and incidentals necessary to complete these items of work in accordance with the following:

1. Item 751-A: Relocate Existing Lighting Control Center. This work includes the removal of a lighting control center and installation at a new location. A lighting control center shall include switches, circuit breakers, contactors, fuses, enclosure, photoelectric controller, control transformer, interior light, interior receptacle, ground rod, incoming service conductors, conduit, anchor bolts, terminal strips, and miscellaneous hardware.

This work also includes the removal of an existing concrete pad and installation of a new concrete pad for the lighting control center, and installation of a new aluminum identification plate.

2. Item 751-B: Replace Lighting Control Center Interior Components. The lighting control center interior components shall include switches, circuit breakers, contactors, control transformer, fuses, photoelectric controller, control transformer, interior light, interior receptacle, ground rod, terminal strips and miscellaneous hardware.

3. Item 751-C: Testing Circuit Insulation. Circuit insulation testing shall include providing test instruments, test preparation, test measurements, recording test readings, locating and identifying causes for low readings, report preparation, and other related miscellaneous services.

4. Item 751-D: Replace Luminaire Components. Luminaire components shall include poles, luminaires, luminaire support arms, pole base breakaway devices, individual lowering devices, roadway luminaire lowering device system (a complete lowering device assembly or any individual component of the lowering device), surge arresters, ballasts, igniters, lamps, fuse holders, fuses, pole wiring cables and connectors, portable power units, power cord sets, and miscellaneous hardware.

5. Item 751-E: Replace High Mast Lighting Components. High mast lighting components shall include the high mast lowering device system (a complete lowering device assembly or any individual component of the lowering device), pole wiring cables and connectors, luminaires, ballasts, lamps, igniters, portable power units, power cord sets and miscellaneous hardware.

6. Item 751-F: Renumber Luminaire Poles. The renumbering of a luminaire pole shall include the removal of the existing numbers, and the installation of a new eight (8) place holder with eight (8) alphanumeric characters.

7. Item 751-G: Remove and Store State Lighting System Equipment. This is State property and shall include loading, transporting, unloading, and uninstalling poles, luminaires, luminaire support arms, pole base breakaway devices, high mast lowering devices, roadway luminaire lowering devices, individual lowering devices, lighting control centers, surge arresters, ballasts, igniters, lamps, fuse holders, fuses, pole wiring cables and connectors, or miscellaneous hardware owned by the State.

8. Item 751-H: Install State Lighting System Equipment. This is State property and shall include loading, transporting, unloading, and installing poles, luminaires, luminaire support arms, pole base breakaway devices, high mast lowering devices, roadway luminaire lowering devices, individual lowering devices, lighting control centers, surge arresters, ballasts, igniters, lamps, fuse holders, fuses, pole wiring cables and connectors, or miscellaneous hardware owned by the State.

9. Item 751-I: Install State Luminaire or High Mast Assembly: This is State property and shall include the loading, transporting, unloading, and installation of complete luminaire assemblies or high mast luminaire assemblies. The complete assemblies shall the pole, luminaires, luminaire support arms, high mast, roadway luminaire or individual lowering devices, pole base breakaway devices, lamps, pole wiring cables and connectors and miscellaneous hardware.

10. Item 751-J: Remove Luminaire Pole Foundation. A luminaire pole foundation shall be a reinforced concrete foundation or an augerbase with drilling and backfilling, concrete pad, reinforcing steel, conduit and elbows, anchor bolts, and mulching and seeding the disturbed ground.

11. Item 751-K: Replace Luminaire. A luminaire shall be a complete high mast, offset, cobra head or other manufactured single luminaire unit, and shall include any hardware required to mount the luminaire to the pole or lowering device.

1**2. Item 751-L: Remove State Lighting System Equipment.** This is State property and shall include loading, transporting, unloading, and uninstalling poles, luminaires, luminaire support arms, pole base breakaway devices, lighting control centers, high mast lowering devices, roadway luminaire lowering devices, individual lowering devices, surge arresters, ballasts, igniters, lamps, fuse holders, fuses, pole wiring cables and connectors, or miscellaneous hardware owned by the State.

13. Item 751-M: Remove Conductors and/or Conduits. Remove and dispose of unused or abandoned electrical conductors and/or conduits including wire, splices, couplings and terminations as indicated on the plans, including labor, equipment, services, transportation and all appurtenances.

14. Item 751-N: Modification of Existing State Lighting System Equipment. This is State property shall include lighting poles, luminaires, luminaire support arms, pole base breakaway devices, lighting control centers, high mast lowering devices, roadway luminaire lowering devices, individual lowering devices, surge arresters, ballasts, igniters, lamps, fuse holders, fuses, pole wiring cables and connectors, or miscellaneous hardware owned by the State.

(b) Payment will be made under Item No.:

751-A Relocate Existing Lighting Control Center (1) - per each
751-B Replace (3) - per each
751-C Testing Circuit Insulation - per each

751-D Replace (4) - per each
751-E Replace High Mast (5) - per each
751-F Renumber Luminaire Poles – per each
751-G Remove and Store (6) - per each
751-H Install State Property (6) - per each
751-I Install State (7) - per each
751-J Remove Luminaire Pole Foundation, (2) - per each
751-K Replace (8) – per each
751-L Remove (6) - per each
751-M Remove (9) – per Lump Sum
751-N Modification of Existing (6) - per each

(1) Number of circuits, type (WP, DE, A, G, NT or Special)
(2) High Mast, Concrete, Auger Base or Special
(3) Lighting Control Center Interior, Circuit Breakers, Contactor, Control, Transformer, Photo Electric Cell, Test Switch, Terminal Strip or Ground Rod
(4) Luminaire Support Arm, Lighting Pole, Transformer Base, Transformer Base Cover, Surge Arrester, Breakaway Fuse Holder, Fuse in Pole Base, Roadway Luminaire, 5 Amp Fuse, Igniter, H.P.S. Lamp, Fusible Plug, Distribution Block, Pole Cable, Submersible Splice Kit, Ballast or Starter
(5) Lowering Device, Head Frame Assembly with Cover, Mounting Ring Assembly, Portable Power Unit, Clevis Plate with Hoisting Cable, Winch and Mounting Plate, Motor Mounting Bracket, Head Frame Roller Assembly, Latch Barrel Assembly, Latch Pin, Power Cord, Luminaire, Ballast, or Lamp
(6) Lighting Control Center, Circuit Breaker, Contactor, Control Transformer, Test Switch, Terminal Strip, Photo Electric Receptacle, Service Pole, Lighting Pole, Luminaire Support Arm, Transformer Base, Surge Arrester, Fuse Holder, Roadway Luminaire, Roadway Luminaire Assembly, High Mast Luminaire, High Mast Luminaire Assembly, H.P.S. Lamp, Roadway Luminaire Lowering Device System, High Mast Head Frame Assembly, High Mast Mounting Ring Assembly, High Mast Clevis Plate with Hoisting Cables, Winch and Mounting Plate, Power Cord, electrical junction box, etc.
(7) Roadway Luminaire Assembly or High Mast Luminaire Assembly
(8) High Mast, Roadway, Cobra Head, Modified Cobra Head, Offset or Segmented Reflector
(9) Conductors, Conduits, Conductors and Conduits

SECTION 756
ELECTRICAL CONDUITS UNDER ROADWAYS

756.01 Description.

This Section shall cover the work of furnishing and installing electrical conduits as detailed by the plans and these specifications. The installation shall include placement of the conduit at the location shown on the plans or directed by the Engineer.

All electrical conduits installed under this Section shall be encased, with the kind of encasement depending on the type of installation as follows:

Type 1 installation - conduit installed by open trench method and having a concrete encasement.
Type 2 installation - conduit installed by an approved jacking or boring procedure and having a steel pipe encasement.
Type 3 installation - conduit installed by open trench method and having a bituminous plant mix backfill and surface treatment (when required).
Type 4 installation - conduit installed by open trench method, having a pipe encasement as shown on the plans, and backfilled as shown on the plans.
Type 5 installation - conduit installed by a precision directional boring method and having a high-density polyethylene (HDPE) encasement.

756.02 Materials.

Materials shall meet the appropriate requirements of Division 800, Materials, and the requirements noted in this Article.

Conduit shall meet the requirements of Article 885.06.

Metal encasement pipe shall meet the requirements of Section 862.

Concrete used to encase conduit in a Type 1 installation shall be Class A concrete meeting the requirements of Section 501.

All electrical equipment shall conform to the standards of the National Electrical Manufacturers' Association (N.E.M.A.), or Underwriters Laboratory, whichever is applicable. Workmanship and materials shall conform to the requirements of the National Electrical Codes, National Electrical Safety Code and with any local codes or ordinances governing electrical installations. All materials and equipment shall be new, except where the plans specifically provide for re-using existing equipment.

Within 30 days after execution of the contract, the Contractor shall submit to the Engineer a list of materials which he proposes to use. The list shall show the name of the manufacturer, size, name and identifying catalog number of each item.

If requested by the Engineer, the Contractor shall submit for inspection and approval samples of the proposed substitute item and bear any extra costs of evaluating the quality of the materials. All lists shall be submitted in quintuplicate for checking and approval. The Department will not be liable for any materials purchased or work done or any delay incurred prior to such approval. Failure of the Engineer to note unsatisfactory material as received will not relieve the Contractor from responsibility.

Omissions from the drawings and specifications, or the misdescription of details of work which are evidently necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omissions and details of work, but they shall be performed as if fully and correctly set forth and described in the drawings and specifications. In any case of discrepancy in figures, catalog numbers, descriptions in the drawings or in the specifications, the matter shall be promptly submitted to the Engineer who shall promptly make a determination in writing. Any adjustment by the Contractor shall be at the Contractor's own risk and expense.

For a Type 3 installation, the trench backfill shall be ALDOT #100 concrete sand and Bituminous Concrete Plant Mix, ALDOT 429, as shown on the plans.

For a Type 4 installation, the trench backfill shall be as shown on the plans.

For a Type 5 installation, the encasement conduit shall be high-density polyethylene (HDPE). The conduit shall meet the requirements given in ASTM F 2160, "Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)". The conduit shall be Schedule 80 or DR 11. The color of all conduits shall be in compliance with the recommendations of the American Public Works Association for the use of the ULCC Uniform Color Code. The color of conduits for electrical power shall be black with longitudinal red striping. The color of conduits for communication media including traffic signals shall be orange or black with longitudinal orange striping. The red or orange longitudinal striping on each conduit shall be at least three stripes spaced at equal distances apart on the circumference of the conduit. The stripes shall be an integral part of the conduit material. Tape and paint stripes will not be accepted for installation.

756.03 Construction Requirements.

(a) General.

All construction and installation of electrical conduits shall be done under direction of specially qualified supervisors. All workmanship shall be in accordance with the latest accepted standard of the industry, as determined by the Engineer.

Upon completion of the contract, the Contractor shall deliver to the Engineer a corrected plan showing in detail the actual location and depth of conduits.

Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphaltic concrete pavement, bituminous surfacing, base material, and any other improvements broken or damaged by the Contractor, shall be replaced or reconstructed with the same kind of materials as found on the work, or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in Portland cement concrete sidewalks and pavements shall be cut to a minimum depth of 1.5 inches {40 mm} with a saw, prior to removing the sidewalk and

pavement materials. Cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

(b) Open Trench Method.

The excavations required for the installation of conduits shall be performed in such a manner as to cause the least possible injury to the street, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least damage and obstruction to vehicular and pedestrian traffic, and the least interference with the surface will occur.

All surplus excavated material shall be removed and disposed of by the Contractor, as directed by the Engineer.

Excavations after backfilling shall be kept well filled and maintained in a smooth and well drained condition until permanent repairs are made.

At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for public travel.

Coordination of this type work with regular roadway or bridge work will be of prime importance to prevent undue damage to completed items of work or existing facilities. Any damage to existing facilities caused by the installation of the ducts shall be repaired by the Contractor at no additional cost to the State.

(c) Jacking or Boring Method.

All conduits installed under paved areas shall be encased in steel pipe. Installation of the casing shall be made prior to placement of the pavement or it shall be jacked or bored through the roadbed under the pavement providing a minimum cover of 30 inches {750 mm}.

The jacking or boring procedure and equipment shall be such that placement of the casement shall be accomplished without producing an unsupported opening through the roadbed between the established ends of the required length of casing. In no event should casing lengths be less than the distance between shoulder limits of a roadway.

The drilling and mud bore method will be acceptable provided the requirements noted in Subarticle 730.03(a) are complied with.

(d) Precision Directional Boring Method.

All conduits installed under paved areas shall be encased in HDPE duct. Installation of the casing shall be made prior to placement of the pavement or it shall be precision directional bored through the roadbed under the pavement at the depth shown on the plans or as approved by the Engineer.

The precision directional boring procedure and equipment shall be such that placement of the casement shall be accomplished without producing an unsupported opening through the roadbed between the established ends of the required length of casing. In no event should casing lengths be less than the distance between shoulder limits of a roadway.

The casing shall be installed by drilling a hole with an open type bit that leaves the cuttings in place. A gel-forming colloidal drilling fluid consisting of at least 20%* high grade carefully processed Bentonite may be used to consolidate cuttings of the cutting bit, seal the walls of the hole and furnish lubrication for subsequent removal of cuttings and installations of the casing immediately thereafter. In this method, when drilling through a dense formation, cuttings may be partially removed from the hole in 3 foot {0.9 m} plugs by use of compressed air as drilling progresses. However, in low density soils of a sandy or silty nature, a plug shall be installed in the mouth of the bore (hole) to prevent the movement of any cuttings from the hole until immediately before installation of the casing. No bit larger than 3 inches {76.2 mm} in diameter shall have holes therein larger than 5/16 inches {8 mm} in diameter through which drilling fluid is forced during boring. The casing shall be installed immediately after the casing hole is completed. In no case will water be used to flush cuttings from the drill hole. The cuttings shall remain in the bore hole except as previously provided for as drilling progresses so as to consolidate them to support the bore wall. The filter cake which is formed by the cuttings and drilling fluid prevents cave-in or sloughing of the drill hole. On completion of the boring, the hole will be swabbed out by pulling through the hole the casing attached to a suitable swab. Violation of any of the above provisions by the Contractor will result in the suspension of work.

* NOTE: By Volume. For instance, 20 gallons {20 L} Bentonite to 80 gallons {80 L} of water.

756.04 Method of Measurement.

The accepted amount of electrical conduit of the type installation required shall be measured by the linear foot {meter} to the nearest foot {0.1 m}.

756.05 Basis of Payment.

(a) Unit Price Coverage.

The accepted electrical conduit, measured as noted above, will be paid at the contract unit price bid for the type installation involved. Said unit price bid shall be full compensation for the furnishing and installation of the electrical conduit, for the specified pipe or concrete encasement, for any required backfill material, for all excavation and backfill, jacking or boring, disposal of excess material, and for all labor, tools, equipment, and incidentals necessary to complete the work.

(b) Payment will be made under Item No.:

756-A ___ inch {mm} Electrical Conduit, __*__ Lines, Type __**__ Installation - per linear foot {meter}

* Specify number of lines in installation

** Specify type of installation

SECTION 757
PORTABLE TRAFFIC SIGNAL

757.01 Description

This Section shall cover the work of furnishing new portable traffic signals or utilizing State furnished portable traffic signals. The furnishing of new portable traffic signals includes all services and operational supplies necessary to provide a functional portable traffic signal unit. All portable traffic signals shall comply with the Manual on Uniform Traffic Control Devices (MUTCD), publications of the Institute of Transportation Engineers (ITE), the National Electrical Manufactures Association (NEMA), the National Electrical Code (NEC), and the International Municipal Signal Association (IMSA).

757.02 Materials.

The portable traffic signal unit shall be complete with power supply, controller, structural support system, all applicable software, communications, and manuals. Portable traffic signals shall be designated according to their type based on Table 4 PTS Type Designations shown in NEMA TS 5-2017, “Standard for Portable Traffic Signal Systems (PTSS) Standard,” or latest revision.

757.03 Construction Requirements.

(a) General.

The Contractor shall set up and level the unit at the designated location shown on the plans and approved by the Engineer. The portable traffic signal unit shall be placed on a base consisting of a fine aggregate compacted to the satisfaction of the Engineer or alternate location approved by the Engineer.

After setup and leveling, the Contractor shall secure the portable traffic signal trailer to protect from theft. If the unit is stolen, the Contractor shall be required to replace the unit at his own expense. The Contractor shall provide adequate flaggers on a 24-hour per day, 7 day a week basis until the unit is replaced and fully operational.

Signal heads positioned over a road surface shall be mounted a minimum of 17 feet from the bottom of the signal head to the top of the road surface. All other signal heads shall be mounted at a minimum of 8 feet from the bottom of the signal head to the top of the ground surface.

The Contractor shall clean, service and repair State furnished units when the Engineer determines that the portable traffic signal unit is no longer needed, and shall return the unit to the specified location shown on plans or specified by the Engineer. The aggregate pad shall be removed and disposed of as directed by the Engineer.

(b) Pay Item 757-A.

The Contractor shall furnish a new or used portable traffic signal unit, and shall be totally responsible for the required performance of the signal.

An acceptable portable traffic signal unit shall be one of the units listed on List IV-3, WORK ZONE TRAFFIC CONTROL DEVICES, Sub-Heading “Portable Traffic Signals” of the Department’s “Materials,

Sources, and Devices with Special Acceptance Requirements" manual. Information concerning this list can also be found in Sub-article 106.01(f).

The Contractor shall retain ownership of the portable traffic signal unit when the Engineer determines that the signal is no longer needed.

(c) Pay Item 757-B.

The Contractor shall furnish a new and fully functional portable traffic signal unit. An acceptable portable traffic signal unit shall be one of the units listed on List IV-3, WORK ZONE TRAFFIC CONTROL DEVICES, Sub-Heading "Portable Traffic Signals" of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" manual.

When the Engineer determines that the portable traffic signal unit is no longer needed, ownership shall be transferred to the Department.

(d) Pay Item 757-C.

The Contractor shall use a State furnished portable traffic signal unit. The Contractor shall pick-up the unit from the location shown on plans or specified by the Engineer. The Contractor shall clean, service and repair the portable traffic signal unit when the Engineer determines that the signal in no longer needed, and shall return the signal to the Department.

757.04 Maintenance Requirements.

The Contractor shall keep the portable traffic signal unit in good repair at all times. Each portable traffic signal unit shall have both signal heads working in full operation at all times with red/yellow/green signal faces functioning properly. Failure, malfunction, or damage to the unit, for any reason, shall require the Contractor to expedite the repair, or replacement, and furnish adequate flaggers or other approved means, at the Contractor's expense, to provide a safe means for the control of traffic until the unit is put back into service. The Contractor shall perform maintenance to the portable traffic signal unit, which includes the periodic cleaning of the unit along with the repair of damage to the protective coating of the unit.

Portable traffic signal unit furnished under Pay Item 757-B (Contractor Furnished) and Pay Item 757-C (State furnished) shall be stored in an approved, secure storage area when not in use. The Contractor shall perform all maintenance operations recommended by the manufacturer of the portable traffic signal and keep complete maintenance records.

757.05 Delivery of Unit and Transfer of Title, Pay Items 757-B and 757-C.

Prior to the completion of the project, and when the Engineer determines that the portable traffic signal unit is no longer needed, the Contractor shall clean and service the unit to insure that the unit is in good operational condition and return all manuals, maintenance records and title transfer (title transfer required under Pay Item 757-B), to the Engineer. The Engineer shall inspect the portable traffic signal unit to insure the unit is operational and undamaged before the Contractor delivers the unit back to the State. The Engineer shall authorize the Contractor to return the portable traffic signal unit to the specified location on the plans or specified by the Engineer, as soon as the inspection is complete.

757.04 Method of Measurement.

Measurement of portable traffic signal will be complete individual portable traffic signal unit for the type of unit furnished.

There will be no overrun of this item without written permission of the Engineer.

757.05 Basis of Payment.

(a) Unit Price Coverage.

The portable traffic signal unit, measured as noted above, will be paid for at the contract unit prices which shall be full compensation for pickup and delivery of unit, installation of aggregate pad, fine aggregate for the pad, set up of unit; and providing and inputting timings of unit for the exclusive use during the project; maintenance and operation of the unit during the life of the contract; removal of the aggregate pad; and includes all equipment, tools, labor, services, supplies, and incidentals necessary to complete this item of work.

The contract price for Pay Item 757-B and 757-C shall also include the cleaning, servicing, and repair of the unit and pickup from and delivery to the designated storage location.

(b) Payment will be made under Item No.:

757-A Portable Traffic Signal, Type _*_ - per Each
757-B State Retained Portable Traffic Signal, Type _*_ - per Each

757-C State Furnished Portable Traffic Signal, Type _*_ - per Each
* Specify Type (TR1 or TR2)

DIVISION 800
MATERIALS

SECTION 800
MATERIALS

800.01 General.

All materials used in the work shall be new, unused material that will meet the requirements described in this Division unless the same are altered by specific requirements of any Section of these Specifications, Special Provisions, or by modifying notes on the plans. All materials shall also meet the requirements of applicable portions of Section 106 which will supplement the requirements of this Section.

All tests shall be in accordance with the current Departmental testing schedule.

800.02 Inspection Arrangements.

(a) Contractors' Notification.

It shall be the duty of the Contractor to notify the Engineer of the source of the various materials required for each project. This notice shall be received sufficiently in advance of any shipment of materials so that inspection may be arranged at the producing plant if the Engineer so elects.

(b) Plant Inspection.

Whenever the quantity of materials warrants such an arrangement and/or it is economically advantageous to the Department, the inspection of materials at the original or immediate source of supply will be made. However, the Department is under no obligation to the Contractor to inspect materials until it arrives at the site of the work. In general, all aggregates, soil, brick, reinforcing and structural steel, bituminous materials, timber, lumber, piling, and posts which are to become a part of the completed work will be inspected at the point of production. For timber, lumber, piling, and posts which are to be given preservation treatment, this inspection will be performed at the treating plant in conjunction with inspection of the treating process.

(c) General Details.

1. For lumber and timber products, the producer shall have sorted his stock and shall have separated a sufficient quantity of material to insure that all of each item for inspection is available before the Inspector is called. In the event that part of the shipment is rejected because of failure to meet the specification requirements, the producer shall furnish other stock to replace the rejected items.
2. Should the quantity of any material rejected for failure to meet specification requirements amount to 20 percent or more of the material inspected and tested at that time, the inspection operation will be suspended until the producer shall have regraded his stock or revised his production methods to produce material uniformly conforming with the specifications.

When sampling stockpiles of aggregates, base materials, etc., the average of all samples must be within the gradation band required for the size aggregate specified. In no case will stockpiles be acceptable if more than 20% of the total samples fall outside the gradation band. In addition, any failing sample must be within 20% of the range specified for any designated sieve.

3. In case the stock has not been properly prepared or separated before calling an Inspector, or in case of delay in replacement of rejected material, the extra inspection cost occasioned by such delay will be charged against the Contractor for whom the material is being produced and will be deducted from any sums due or which may become due the Contractor.
4. Where a Contractor's producer or jobber requests inspection of material for warehouse stock or for use in plants where stocks of materials inspected and accepted for use in highway construction or maintenance cannot be kept separated from materials which are to be used on other work, the cost of inspection of those materials which have been approved for highway work, but are later diverted to other uses not connected with the Department's highway construction or maintenance, will be charged to the Contractor who requested such inspections.

800.03 Testing, General.

Where maximum and minimum specification limits are given, it is intended and expected that materials having approximately mean values will be furnished under the respective specifications. The established allowances for variations in the determination of these values are considered in establishing the limits and no tolerances in excess of the established variation allowances will be permitted unless so specifically stated in the proposal or on the plans.

Unless otherwise specified in the test procedure or material specification, all test results will be rounded off in accordance with ASTM E 29 and reported to the same number of places as the specification.

Where material is fabricated of or treated with another material or any combination of materials is assembled to form a product, any or all of which are covered by these specifications, the failure of any of the components of the product to comply with the designated specifications shall be deemed sufficient cause for the rejection of the whole.

The sieves used for testing materials shall be woven wire cloth conforming to ASTM E 11.

800.04 Tests for Concrete Materials.

Preliminary samples of fine aggregate, water, and cement shall be subject to both 7 and 28 day tests or their equivalent and acceptance based thereon. During the progress of the work, these materials may be accepted on the basis of the 7 day test, except that Type III cement may be accepted on the basis of the 3 day test.

800.05 Bituminous Mixture Stability and Density Test.

These tests shall conform to the current methods as described in ALDOT-307 or ALDOT-344, depending on the maximum aggregate size.

800.06 Measurement of Liquid Bituminous Materials.

(a) Measurement.

Actual measurement shall be in accordance with the provisions of Subarticle 109.02(a) and/or (b).

(b) Procedure.

Unless otherwise provided in the proposal form, the procedure in conjunction with all shipments in tank cars or trucks shall be as follows:

1. The producer or supplier shall furnish to the Engineer in charge of the project a shipping notice (Form BMT-146) for each shipment, containing the following information:
   - Tank number and initials, if any.
   - Type, grade, and weight {mass} of bituminous material contained.
   - Date of Shipment.
   - Shipping Point.
   - Destination.
   - Consignee.
   - Project Number.
   - Temperature of bituminous materials, degrees Fahrenheit {Celsius}, at time truck tank was measured.

   Failure to furnish data will be cause for rejecting the shipment.
2. Before each shipment of bituminous material is unloaded, the Engineer shall be given opportunity to make such measurement as necessary to determine the net quantity of materials delivered.
3. Conversion of verified weight to gallons {mass to liters} may be used for measurement purposes provided prior written approval is obtained from the Engineer.

800.07 Soil Analysis Test.

(a) Mechanical Analysis.

This test shall be performed in accordance with AASHTO T 88.

(b) Elutriation Test for Clay.

This test shall be performed in accordance with AASHTO T 88.

(c) California Bearing Test.

The California Bearing Test shall be performed in conformity with AASHTO T 193 as modified by ALDOT-115.

(d) Liquid Limit.

This test shall be performed in accordance with AASHTO T 89 as modified by ALDOT-232.

800.08 Field Performance Test.

In addition to specifications and tests specified, it may be necessary to have certain materials undergo field performance testing for a prescribed period. The materials involved and the specified field performance testing will be determined by the Department's Product Evaluation Board (PEB). The PEB will determine which type of material will require this field performance testing and the duration thereof. In general, this will include materials such as Pavement Markers, Concrete Joint Fillers and Sealants, Concrete Patching Materials, Epoxies, Reflective Material for Object Safety Markings, Membranes for Waterproofing Joints, and certain pavement marking materials.

SECTION 801
COARSE AGGREGATE

801.01 Description.

(a) General.

Coarse aggregate shall consist of crushed or uncrushed gravel, crushed stone, or crushed slag, having hard, strong, durable pieces, free from adherent coatings and conforming to the requirements provided in this Section. Gravel aggregate for use in bituminous plant mixes and bridge superstructure concrete (except prestressed concrete) shall have a bulk specific gravity greater than 2.550 (AASHTO T 85).

(b) Acceptance.

The Department has established a list of qualified producers of coarse aggregates. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

All coarse aggregates furnished shall come from an approved producer who is participating in and meeting the requirements of ALDOT-249, "Quality Control Program for Acceptance of Fine and Coarse Aggregates". The producer's name shall be listed in the Department's "Materials, Sources and Devices With Special Acceptance Requirements" manual, List I-1.

801.02 Deleterious Substances.

Material suspected of containing deleterious substances will be examined in the laboratory and will be rejected if the amount is considered objectionable.

Coarse aggregate for Portland cement concrete and cover aggregate for bituminous treatment shall be washed and shall be free from adherent coatings. Coating on crushed stone shall be dust of fracture as determined by washing the material passing the No. 200 {75 µm} sieve in accordance with AASHTO T 11 or visual inspection using a petrographic microscope. Adherent coating will be checked by washing in a large container without scrubbing or applying water pressure. The aggregate will then be checked for adherent coating by visual inspection. Aggregate that has an adherent coating will not be acceptable.

The amount of deleterious substances shall not exceed the limits shown in the following table.

MAXIMUM ALLOWABLE DELETERIOUS MATERIALS IN COARSE AGGREGATE		
TYPE OF DELETERIOUS MATERIAL	Bituminous Surface Treatments and Concrete Classes A, B and D***	All Other Uses
Coal and Lignite (Visual)	0.25 %	0.25 %
Clay Lumps (AASHTO T 112)	0.25 %	0.25 %
Material Passing the No. 200 {75 µm} Sieve (AASHTO T 11)	1.0 %	2.0 %
Flat or Elongated particles (5:1 Ratio) (ASTM D 4791 by Weight {Mass})	10.0 %	10.0 %
Flat or Elongated particles (3:1 Ratio) (ASTM D 4791 by Weight {Mass})	20.0 %	20.0 %
Other local deleterious substances (Shale, Mica, Marcasite, etc.) (Visual)	2.0 %	2.0 %
Reactive Silica (via ASTM C 25) (* restrictions apply to the use of limestone in Portland Cement Concrete)	8.0 %	8.0 %
Absorption	**	**
* See NOTE 1 following this table. ** See NOTE 2 following this table. *** See NOTE 3 following this table.		

NOTE 1: One of the three following options shall be used for the design of concrete mixes with limestone aggregates that contain more than 8.0% silica. The submittal of a concrete mix design using limestone aggregate with more than 8% silica will not be approved if it does not include one of the following three options.

Option 1: Class F fly ash shall be substituted for cement at a fixed rate of 20% replacement by weight.

Option 2: Ground Granulate Blast Furnace Slag (GGBFS) shall be substituted for cement at a fixed rate of 50 % replacement by weight. GGBFS increases the time of setting of concrete, therefore this option shall be used only for concrete placed at ambient temperatures of 45 ºF {7 ºC} or above.

Option 3: Class C fly ash and microsilica shall be substituted for cement at a fixed rate of 35 % replacement by weight. The distribution of the replacement shall be 30 % Class C fly ash and 5 % microsilica by weight.

NOTE 2: The restriction of the amount of absorption applies to gravel aggregates only for the following applications. Gravel for use in bituminous plant mixes and bridge superstructure concrete (except prestressed concrete) shall have a total sample absorption not greater than 2.0 percent on the material passing the 3/4 inch {19.0 mm} sieve and retained on the No. 4 {4.75 mm} sieve as per modified AASHTO T 85. Section 8.1 of AASHTO T 85 shall be modified to require a 15 minute vacuum saturation period as per Section 6.3 of AASHTO T 209 prior to the required 15-19 hour soaking period.

NOTE 3: The maximum allowable deleterious materials in coarse aggregate used in Class A concrete applies only to concrete used for bridge substructures, box culverts, retaining walls, and concrete safety barriers.

801.03 Crushed Stone, Gravel, and Crushed Gravel.

(a) General.

Crushed stone shall be from approved ledges or working strata within an approved source and shall consist of clean, tough, durable fragments, reasonably free of shale, conforming to requirements for the type use noted in Subarticle 801.03(b) and the gradation specified.

Gravel shall consist of a clean, tough, durable, natural rounded or semi-rounded siliceous rock, free from coatings of any character, and conforming to the gradation specified. Crushed gravel shall consist of crushed fragments of gravel, conforming to the requirements of Subarticles (a) and (b) of this Article.

Gravel for use in bituminous plant mixes and bridge superstructure concrete (except prestressed concrete) shall have a bulk specific gravity greater than 2.550 (AASHTO T 85).

Unless otherwise specified, at least 80 percent by weight {mass} of the blended aggregate retained on the No. 4 {4.75 mm} sieve shall have at least two fully fractured faces measured in accordance with ASTM D 5821.

(b) Physical Tests.

Crushed stone, gravel, and crushed gravel shall meet the following requirements for the respective physical tests:

		Cement Concrete	Bituminous Work	All Other Uses
1.	Percent Wear Los Angeles Test (AASHTO T 96)	50 Max.	48 Max. *	60 Max.
2.	Percent Sound, Soundness Test (AASHTO T 104 using Sodium Sulphate and 5 Cycles)	90 Min.	90 Min.	90 Min.
* Except for Sandstone and Blast Furnace Slag, 55 Max.				

801.04 Blank.

801.05 Crushed Slag.

(a) General.

Slag is defined as a stone-like siliceous material with porous faces produced as a by-product of various manufacturing processes.

Crushed slag produced from processing slag obtained from sources approved by the Materials and Tests Engineer shall consist of clean, tough, durable pieces, reasonably uniform in density and quality without thin or elongated pieces, free from deleterious substances, and conforming to the specified gradation.

Crushed slag furnished for use in Bituminous Wearing Surface layers shall, in addition to the above, be restricted in its glassy particles content, when tested in accordance with ALDOT-321 to the following:

Type Wearing Surface	Glassy Particle Content
Surface Treatments	10% Maximum
Open Graded P.M.	10% Maximum
Dense Graded P.M.	25% Maximum

(b) Physical Tests.

Physical tests for crushed slag shall be the same as provided by Subarticle 801.03(b) for the type of construction specified, i.e., soil type, or bituminous.

801.06 Coarse Aggregate for White Concrete.

This coarse aggregate shall be white or very light colored gravel, limestone, marble, or granite, subject to the approval of the Engineer for color and otherwise conforming to the specifications of this section for coarse aggregate. The size number will be shown on the plans and/or proposal.

801.07 Coarse Aggregate for Mastic (For Water Proofing Concrete Surfaces).

Coarse aggregate for mastic shall be a well crushed stone, slag, or washed gravel that will pass a 3/8 inch {9.5 mm} sieve and be retained on a No. 8 {2.36 mm} sieve. It shall be free from soft particles and organic matter.

801.08 Gradation.

Coarse aggregate shall be graded between the limits specified and the size or sizes designated shall conform to the limits shown in the following Coarse Aggregate Gradation Table provided in Subarticle 801.11(d).

801.09 Aggregates for Base.

Aggregates for base layers shall consist of gravel, crushed gravel, crushed slag, or crushed stone as specified for the type of base designated; however, sand and gravel from local roadside pits will only be required to comply with the applicable portion of Section 826.

801.10 Aggregates for Bituminous Work.

Aggregate for bituminous work shall be one or a combination of the aggregates specified for the type of bituminous work involved. It shall be uniformly graded so as to meet the gradation requirements for the size designated to be used. The aggregate shall be of such nature that, when once thoroughly

dried and coated with the bituminous material proposed for construction, the coating will not strip off upon contact with water.

801.11 Use, Care, and Handling: Gradation Table and Explanation.

(a) Care and Handling.

Care and handling shall be as provided by Article 106.05.

(b) Storage.

Attention is directed to the requirements of Article 106.05 and the following:

1. The Contractor shall prepare the storage area as needed; any stockpiled material that cannot be removed without including dirt or other foreign matter shall be rejected.
2. Stockpiling shall be as provided by ALDOT-175.
3. Different sizes of aggregate and aggregate from different sources shall be stored in separate stockpiles sufficiently separated from each other so that the material will not become intermixed. Any material which segregates so that the grading no longer conforms to that specified shall be rejected for use.

(c) Use.

1. At the time of their use, the aggregates shall be free from all foreign materials.
2. When more than one size of aggregate is required, the various sizes shall be combined in proper proportions at the mixer or plant.
3. Aggregates stored in proportioning bins shall be protected from rain by waterproof coverings.

(d) Coarse Aggregate Gradation Table.

TABLE OF ALDOT COARSE AGGREGATE SIZES *

PERCENT PASSING BY WEIGHT {MASS}, EACH LABORATORY SIEVE (U.S.A. STANDARD SERIES)

Size > / Number ∨	4 inch {100 mm}	3.5 inch {90 mm}	3 inch {75 mm}	2.5 inch {63 mm}	2 inch {50 mm}	1.5 inch {37.5 mm}	1 inch {25.0 mm}	3/4 inch {19.0 mm}	1/2 inch {12.5 mm}	3/8 inch {9.5 mm}	# 4 {4.75 mm}	# 8 {2.36 mm}	# 16 {1.18 mm}	# 50 {300 μm}	# 100 {150 μm}	# 200 {75 μm}
1	100	90-100		25-60		0-15		0-5								
2			100	90-100	35-70	0-15		0-5								
24			100	90-100		25-60		0-10	0-5							
3				100	90-100	35-70	0-15		0-5							
357				100	95-100		35-70		10-30		0-5					
4					100	90-100	20-55	0-15		0-5						
467					100	95-100		35-70		10-30	0-5					
410					100	85-100	60-85		30-60		18-30	11-20	8-15	5-9		2-6
5						100	90-100	20-55	0-10	0-5						
56						100	90-100	40-85	10-40	0-15	0-5					
57						100	95-100		25-60		0-10	0-5				
6							100	90-100	20-55	0-15	0-5					
67							100	90-100		20-55	0-10	0-5				
68							100	90-100		30-65	5-25	0-10	0-5			
610							100	90-100		25-60		7-30		0-15		
7								100	90-100	40-70	0-15	0-5				
78								100	90-100	40-75	5-25	0-10	0-5			
710								100	90-100	50-85		12-35		0-15		
8									100	85-100	10-30	0-10	0-5			
89									100	90-100	20-55	5-30	0-10	0-5		
810									100		70-90	50-74	38-62	20-42		9-24
8910									100	90-100	60-85	40-70		10-25		1-5
9										100	85-100	10-40	0-10	0-5		
10										100	85-100				10-30	

* Explanation of Table

1. Tabulated figures are percentages by weight {mass} of material finer than each laboratory sieve.

2. Exclusive of lightweight aggregates, the minimum dry rodded weight per cubic foot {mass per cubic meter} shall be 65 pounds {1040 kg} for Sizes 1, 3, and 4, and 70 pounds {1120 kg} for other sizes. See Article 801.12 for weight {mass} of lightweight aggregate.

The following coarse aggregate (gravel only) gradation may be substituted for use in concrete headwalls, inlets, miscellaneous concrete units, slope paving, machine laid curbs, gutters, or combination curbs and gutters:

Sieve Size (Square Openings)	Percent Passing By Weight {Mass}
1.5 inches {37.5 mm}	100
1 inch {25.0 mm}	80 – 100
3/4 inch {19.0 mm}	70 – 100
1/2 inch {12.5 mm}	25 - 80
# 4 {4.75 mm}	0 - 15
# 8 {2.36 mm}	0 - 10

801.12 Lightweight Aggregates for Bituminous Work.

Lightweight Aggregates of expanded clays or shales produced by the Rotary Kiln Method shall meet the requirements noted herein in this Section except the maximum dry rodded weight {mass} shall be 55 pounds per cubic foot {880 kg/m^3} and the L.A. Abrasion Test (AASHTO T 96) shall be modified to compensate for lightweight aggregate by the use of the following method.

Modification to AASHTO T 96 for Lightweight Aggregate:

To avoid the excessive volume of material in the testing machine which will occur when the lightweight aggregate sample is prepared according to AASHTO T 96, it is necessary to reduce the weight {mass} proportionately to obtain an equal volume of lightweight aggregate comparable to that normally obtained with a conventional aggregate sample.

The abrasive charge must also be reduced in a similar manner.

1. Determine the unit weight {mass} (U_L) of the lightweight aggregate by AASHTO T 19.
2. Assume an average unit weight {mass} of conventional aggregate to be 97.0 pounds per cubic foot {1554 kg/m^3}.
3. Reduce the lightweight aggregate sample.

$$\frac{U_L}{97.0} = \frac{X}{C} \qquad \left\{ \frac{U_L}{1554} = \frac{X}{C} \right\}$$

$$X = \frac{(C)\,(U_L)}{97.0} \qquad \left\{ X = \frac{(C)\,(U_L)}{1554} \right\}$$

Where:

U_L = Unit weight {mass} of lightweight aggregate sample (pounds per cubic foot {kilograms per cubic meter})

C = Weight {Mass} of Conventional aggregate required for grading in AASHTO T 96.

X = Reduced lightweight aggregate sample charge.

4. Reduce the abrasive charge:

$$\frac{U_L}{97.0} = \frac{X_1}{C_L} \qquad \left\{ \frac{U_L}{1554} = \frac{X_1}{C_L} \right\}$$

$$\frac{X_1}{X} = \frac{\dfrac{(C_L)\,(U_L)}{97.0}}{} \qquad \left\{ \frac{X_1}{X} = \frac{\dfrac{(C_L)\,(U_L)}{1554}}{} \right\}$$

Where:

U_L = Unit weight {mass} of lightweight aggregate (pounds per cubic foot {kilograms per cubic meter})

C_L = Weight {Mass} of abrasive charge required for grading in AASHTO T 96.

X_1 = Reduced abrasive charge for lightweight aggregate.

5. Remainder of procedure as set forth in AASHTO T 96.

NOTE: It is sometimes impossible to obtain the exact abrasive charge with the steel balls available. In this case, obtain the closest abrasive charge possible to the reduced value and then adjust the weight {mass} of the sample in proportion to the new abrasive charge.

SECTION 802
FINE AGGREGATES

802.01 Description.

(a) General.

Fine aggregate shall consist of natural or manufactured sand having hard, clean, durable, uncoated particles and conforming to the requirements provided in this Section.

(b) Acceptance.

The Department has established a list of qualified producers of fine aggregates. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

All fine aggregates furnished shall come from an approved producer who is participating in and meeting the requirements of ALDOT-249, "Quality Control Program for Acceptance of Fine and Coarse Aggregates". The producer's name shall be listed in the Department's "Materials, Sources and Devices With Special Acceptance Requirements" manual, List I-1.

802.02 Concrete Sand.

(a) Description.

Concrete sand shall consist of natural sand, blends of natural sand, blends of natural and manufactured sand, or manufactured sand. The use of manufactured sand shall be limited to the conditions noted in Article 802.06.

Blended sand shall be mixed and tested for gradation after blending has been completed.

The sand shall be washed and have strong, hard, clean, durable particles meeting the physical requirements noted below and the gradation requirements of ALDOT Size No. 100. There will be no fineness modulus or mortar strength requirements for concrete sand used in bituminous pavements.

(b) Deleterious Substances.

1. The maximum weight {mass} of deleterious substances shall not exceed the following requirements:

Materials passing the # 200 {75 µm} sieve removed by decantation shall be subject to approval or rejection based on the following:

a. If any sample has more than 2.5% material passing the # 200 {75 µm} sieve by decantation, the stockpile will be rejected.
b. An average will be made of the samples tested by decantation through the # 200 {75 µm} sieve. If the average is greater than 2.0%, the stockpile will be rejected. If the average is 2.0% or less, the stockpile will be accepted.
c. If smaller quantities of the fine aggregate are being tested where only one sample would be required, this sample will be required to comply with a 2.0% maximum removed by decantation, not to exceed the following percentages:

Shale	1.0 %
Coal and/or Lignite	0.5 %
Clay Lumps	0.5 %
Cinders and Clinkers	0.5 %
Other local deleterious substances (such as alkali, mica, coated grains, soft and flaky particles)	1.0 %
Total shale, coal, and/or lignite, clay lumps, cinders and clinkers, and other local deleterious substances	3.0 % Maximum

Concrete sand to be used in concrete headwalls, inlets, miscellaneous concrete units, slope paving, machine laid curbs, gutters, or combination curbs and gutters shall comply with the above except that not more than 3.0 percent shall pass the # 200 {75 µm} sieve by decantation.

2. The percentage of clay lumps shall be determined by examining the various fractions which remain after the test for grading. An indication of clay lumps shall require testing in accordance with AASHTO T 112 to determine the amount of clay lumps.

3. The diameter of deleterious substances shall not exceed the maximum size of aggregate.

(c) Organic Impurities.

All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength or concrete strength tests as outlined in Subarticles 802.02(e) and (f).

(d) Soundness.

When subjected to five cycles of the soundness test of fine aggregate by the use of sodium sulphate the measured percentage of loss shall not be more than 10 percent by weight {mass} when tested by AASHTO T 104. In lieu of the soundness test, satisfactory evidence may be provided that the fine aggregate has been exposed to natural weathering, either directly or in concrete for a period of at least five years without appreciable disintegration.

(e) Mortar Strength.

When tested in accordance with AASHTO T 71, fine aggregate shall have compressive strength not less than 95% of treated sand as prescribed in AASHTO T 71 at 3 days and 14 days with the use of Type III Portland cement or at 7 days and 28 days with Type I or Type II Portland cement.

(f) Concrete Strength.

Fine aggregate failing to meet the requirements herein provided for mortar strength may be used if (1) when tested in combination with the cement and coarse aggregate to be used in the work, the crushing or tensile strength of the concrete at the end of 7 days (3 days with Type III cement used) and 28 days is at least equal to the strength obtained from specimens made with sand meeting the requirements for the class of concrete in which the material is to be used, or (2) when the past performance record of the aggregate with the particular cement has been satisfactory.

(g) Gradation Uniformity.

The gradation of ALDOT Size No. 100 fine aggregate from any one source shall be reasonably uniform. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples from the source in accordance with the provisions of AASHTO M 6 for fineness modulus (F.M.) determination.

The following schedule will apply to ALDOT Size No. 100 fine aggregate for various kinds of concrete.

Portland Cement Concrete Pavement, Bridge Superstructure Concrete, and Prestressed Concrete:

F.M. 2.30 Min. 3.00 Max.
Establish Working F.M. (W.F.M.)
Tolerance from W.F.M. is plus or minus 0.20

Structure Concrete (Other Than Bridge Superstructure Concrete):
F.M. 2.30 Min. 3.00 Max.

Working F.M. is not required, however, if the F.M. exceeds 2.80 the Contractor will be required to increase the designated cement volume by 0.25 bags per cubic yard {0.25 bags per cubic meter} without additional cost to the State. If requested in writing by the Contractor, consideration will be given to using fly ash in the mix to increase the fines. The fly ash will be substituted for cement as directed by the Materials and Tests Engineer.

There will be no F.M. requirements on concrete sand used in concrete headwalls, inlets, miscellaneous concrete units, slope paving, machine laid curbs, gutters, or combination curbs and gutters.

802.03 Mortar Sand.

Sand for mortar, ALDOT Size No. 101, shall consist of washed, hard, strong, durable, uncoated mineral or rock particles, reasonably free from injurious amounts of organic or other deleterious substances and meeting applicable requirements of Article 802.02.

802.04 Bituminous Pavement Fine Aggregate.

Fine aggregate for use in bituminous paving mixtures is defined as aggregate passing the 3/8 inch {9.5 mm} sieve and with a minimum 80 percent passing the No. 4 {4.75 mm} sieve. The aggregate may

be natural fine aggregate or manufactured fine aggregate. The fine aggregate shall be non-plastic when tested in accordance with AASHTO T 89, as modified by ALDOT-232, and AASHTO T 90 and shall have a maximum of 1.0 percent clay lumps and friable particles as determined by AASHTO T 112. It shall consist of hard tough grain, free of injurious amounts of clay, loam, or other deleterious substances.

Manufactured fine aggregate shall be the product produced from the crushing of aggregates meeting the requirements of Section 801 and shall have 100 percent passing the 3/8 inch {9.5 mm} sieve with 95 percent of the material retained on the No. 8 {2.36 mm} sieve having at least one freshly fractured face.

Natural fine aggregate is defined as any fine aggregate that is not manufactured fine aggregate. Natural fine aggregate shall be reasonably clean, non-plastic, and uniformly graded sand which shall pass the 3/8 inch {9.5 mm} sieve and not have more than 10 percent passing the No. 200 {75 µm} sieve when tested in accordance with AASHTO T 11 and T 27.

Mineral filler meeting the requirements of Section 805, agricultural limestone, or carbonate stone screenings may be used when additional fines are needed.

802.05 Blank.

802.06 Manufactured Sand for Portland Cement Concrete.

Manufactured sand shall meet all of the requirements for ALDOT #100 concrete sand, Article 802.02, except the requirement of Subitem 802.02(b)1a may be increased to five percent if the material is "Dust of Fracture."

Manufactured sand may be produced from crushing gravel, granite, sandstone, or quartzite which may be used either as a blend with natural sand or as one hundred percent of the total fine aggregate. Gravel used to produce manufactured sand for use in concrete pavement or bridge superstructure concrete (except prestress concrete) shall have a bulk specific gravity greater than 2.550 (AASHTO T 85).

Manufactured sand produced from crushing limestone shall not be used in bridge decks or concrete pavement. However, manufactured limestone sand may be used in prestressed or precast concrete, or cast in place concrete, which will not be exposed to vehicular traffic, if approved by the Engineer.

802.07 Fine Aggregate for White Concrete.

Fine aggregate for white concrete shall be a natural white, washed sand and/or an artificial sand made from white quartz, crushed white limestone, white marble, or white granite and shall contain no discoloring material, clay loam, or other foreign matter. It shall be secured from sources previously tested and approved by the Department for whiteness and light reflecting qualities or by visual comparison shall be, in the opinion of the Engineer, at least as white as the approved standard sample on file in the Engineer's office. Other requirements for this fine aggregate shall conform to Article 802.02, with the gradation requirements in accordance with ALDOT Size No. 106.

802.08 Blank.

802.09 Gradation.

Fine aggregate shall be well graded between the limits specified and the size or sizes designated shall conform to the limits shown in the Fine Aggregate Gradation Table.

TABLE OF ALDOT FINE AGGREGATE SIZES

Aggregate Size Number	DESCRIPTION	PERCENT PASSING BY WEIGHT {MASS}, SIEVE SIZE [1]						
		3/8 inch {9.5 mm}	No. 4 {4.75 mm}	No. 8 {2.36 mm}	No. 16 {1.18 mm}	No. 50 {300 µm}	No. 100 {150µm}	No. 200 {75µm}
100	Concrete Sand	100	95-100	80-100	50-90	5-30	0-10	
101	Mortar Sand			100		15-40	0-10	
104	Plant Mix Sand	100	80-100					
105	Manufactured Sand	100	95-100		50-80	20-50	10-25	5-12
106	White Concrete Fine Aggregate	100	95-100	75-100	50-90	10-35	5-15	0-5

NOTES:

1. Figures are percentages by weight {mass} of material finer than each sieve.
2. The F.M. for Size No. 100 when used in Portland cement concrete pavement shall be 2.30 minimum, 3.00 maximum.
3. See Articles No. 802.02 to 802.07 for descriptions.

OPTIONAL TABLE OF ALDOT FINE AGGREGATE SIZES FOR CONCRETE TYPES 2, 3, & 4								
DESCRIPTION	PERCENT PASSING BY WEIGHT {MASS}, SIEVE SIZE							
	1/2 inch {12.5 mm}	3/8 inch {9.5mm}	No. 4 {4.75 mm}	No. 8 {2.36 mm}	No 16 {1.18 mm}	No. 30 {600 μm}	No. 50 {300 μm}	No. 100 {150 μm}
Concrete Sand	100	95-100	85-100	75-100	50-90	30-80	5-45	0-10

NOTE: Concrete sand for concrete headwalls, inlets, miscellaneous concrete units, slope paving, machine laid curbs, gutters, or combination curbs and gutters may meet this gradation in lieu of the ALDOT Size No. 100 Concrete Sand gradation given above.

802.10 Aggregate for Bituminous Work.

The provisions of Article 801.10 are applicable to all Fine Aggregate used in bituminous work.

802.11 Use, Care, and Handling; Gradation Table.

Use, care, and handling of fine aggregate shall be in accordance with the provisions of Article 801.11, modified with respect to fine aggregate where necessary.

SECTION 804
ASPHALT MATERIALS

804.01 General.

The asphalt materials furnished shall be of approved quality and shall meet the requirements shown under its respective type in the following tables and referenced specifications for the kind of material furnished. For any contract, the material furnished shall show uniform test results. Where more than one grade of material is permitted for any item of work, the Engineer shall specify the grade . In all cases, the Engineer will specify the consistency limits for the grade of material shown on the plans and/or proposal. The Contractor may, without extra compensation, supply asphalt material containing approved additives for producing non-stripping characteristics. For such materials, an adjustment in the total asphalt requirements of this subdivision will be made as deemed necessary. Other additives shall not be added to the asphalt material unless expressly authorized in writing by the Materials and Tests Engineer. The use of any unauthorized additive will be cause for rejection of the asphalt material.

Sampling of tank cars, tank trucks, distributor trucks, or recirculating storage tanks shall be by the use of a sampling valve, installed in the tanks, as prescribed in Figure 2 of AASHTO R 66.

All products furnished for use shall be from an approved producer who is participating in and meeting the requirements of ALDOT-243, ACCEPTANCE PROGRAM FOR ASPHALT MATERIALS, and listed on List I-4, PRODUCERS OF ASPHALT PRODUCTS, of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

804.02 Performance Graded Asphalt Binders (PGAB).

The material supplied under this Article shall be asphalt prepared by the refining of asphaltic petroleum. No air-blown or oxidized asphalt will be allowed. The refined asphalt binder shall be homogeneous, free of water and shall not foam when heated at 347 °F {175 °C}.

The PG 58-22, PG 64-22, and PG 76-22 binders shall conform to the requirements given in AASHTO M-320 as shown in Tables 1, 2 and 4 in Article 804.07. The PG 67-22 binder (not shown in AASHTO M-320) shall conform to the requirements given in AASHTO M-320 and the requirements given in Table 3 of Article 804.07.

Shipping temperature of the asphalt from the refinery shall not exceed 356 °F {180 °C} for unmodified binders. For polymer modified binders, shipping temperatures in excess of 356 °F {180 °C} may be allowed with the approval of the Materials and Tests Engineer. At the time of use, the asphalt temperature shall comply with the requirements of Item 401.03(d)2. or Subarticle 410.02(b) whichever is applicable.

804.03 Cutback Asphalt.

The materials supplied under this Article shall be made from liquid asphalt binder and naphtha solvent, so proportioned and mixed that the finished product shall be homogeneous and conform to the requirements of AASHTO M 81 for rapid curing cutback and AASHTO M 82 for medium curing cutback.

804.04 Emulsified Asphalt.

The materials supplied under this Article shall be homogeneous emulsification of asphalt and shall show no separation of asphalt or objectionable change in viscosity within three months after delivery. Separation at any time caused by freezing or contamination shall be cause for rejection. Emulsified asphalt shall conform to the requirements as shown in Asphalt Materials Table No. 5 in Article 804.07.

804.05 Emulsified Petroleum Resin.

The material supplied under this Article shall be a homogeneous emulsification of petroleum resin. The emulsified petroleum resin shall be supplied from the producer in the form in which it shall be placed. No dilution of the product will be allowed after the product has left the supplier's facility. Emulsified petroleum resin shall conform to the requirements as shown in Asphalt Materials Table No. 6. in Article 804.07.

804.06 Blank.

804.07 Tables of Asphalt Materials.

(a) Asphalt Materials Table Number 1, Grade PG 58-22.

ASPHALT MATERIALS TABLE NO. 1 SPECIFICATIONS FOR PERFORMANCE GRADED ASPHALT BINDER		
Property	**Grade PG 58-22**	
	Specification	Test Method
Original Binder		
Flash Point Temperature	Minimum 230 °C	AASHTO T 48
Rotational Viscosity	Maximum 3 Pa•s @ 135 °C	AASHTO T 316
Dynamic Shear, G*/sin δ	Minimum 1.00 kPa @ 58 °C	AASHTO T 315
Rolling Thin Film Oven Residue (AASHTO T 240)		
Mass Loss (RTFO)	Maximum 1.00 %	AASHTO T 240
Dynamic Shear, G*/sin δ	Minimum 2.20 kPa @ 58 °C	AASHTO T 315
Pressure Aging Vessel Residue (AASHTO R 28)		
Dynamic Shear, G*•sin δ	Maximum 5000 kPa @ 22 °C	AASHTO T 315
Creep Stiffness, S	Maximum 300 MPa @ -12 °C	AASHTO T 313
m-value	Minimum 0.300 @ -12 °C	AASHTO T 313

(b) Asphalt Materials Table Number 2, Grade PG 64-22.

ASPHALT MATERIALS TABLE NO. 2 SPECIFICATIONS FOR PERFORMANCE GRADED ASPHALT BINDER		
Property	**Grade PG 64-22**	
	Specification	Test Method
Original Binder		
Flash Point Temperature	Minimum 230 °C	AASHTO T 48
Rotational Viscosity	Maximum 3 Pa•s @ 135 °C	AASHTO T 316
Dynamic Shear, G*/sin δ	Minimum 1.00 kPa @ 64°C	AASHTO T 315
Rolling Thin Film Oven Residue (AASHTO T 240)		
Mass Loss (RTFO)	Maximum 1.00 %	AASHTO T 240
Dynamic Shear, G*/sin δ	Minimum 2.20 kPa @ 64 °C	AASHTO T 315
Pressure Aging Vessel Residue (AASHTO R 28)		
Dynamic Shear, G*•sin δ	Maximum 5000 kPa @ 25 °C	AASHTO T 315
Creep Stiffness, S	Maximum 300 MPa @ -12 °C	AASHTO T 313
m-value	Minimum 0.300 @ -12 °C	AASHTO T 313

The binder shown in Table No. 2 shall be made by adding polymer to a refined grade of PG 58-22 or shall be blended from PG 76-22 using an ALDOT approved blending procedure at the refinery. Air blown and oxidized asphalt shall not be used.

All PG 64-22 shall contain a minimum of 1.5 %, by weight, polymer solids.

A sample and infrared scan (Fourier Transform Infrared, FTIR) using the ALDOT 408 test method to determine the styrene and butadiene peaks and polymer percentage at the appropriate polymer loading shall be submitted to the Materials and Tests Engineer for laboratory evaluation prior to use.

All polymers shall conform to Section 811 for polymer additives.

All Polymer Modified Asphalt Binder manufacturers shall submit the information required in Article 811.01 annually or upon request by the Department.

(c) Asphalt Materials Table Number 3, Grade PG 67-22.

ASPHALT MATERIALS TABLE NO. 3 SPECIFICATIONS FOR PERFORMANCE GRADED ASPHALT BINDERS (NOT SHOWN IN AASHTO M-320)		
Property	**Grade PG 67-22**	
	Specification	Test Method
Original Binder		
Flash Point Temperature	Minimum 230 °C	AASHTO T 48
Rotational Viscosity	Maximum 3 Pa•s @ 135 °C	AASHTO T 316
Dynamic Shear, G*/sin δ	Minimum 1.00 kPa @ 67 °C	AASHTO T 315
Rolling Thin Film Oven Residue (AASHTO T 240)		
Mass Loss (RTFO)	Maximum 1.00 %	AASHTO T 240
Dynamic Shear, G*/sin δ	Minimum 2.20 kPa @ 67 °C	AASHTO T 315
Pressure Aging Vessel Residue (AASHTO R 28)		
Dynamic Shear, G*•sin δ	Maximum 5000 kPa @ 26.5 °C	AASHTO T 315
Creep Stiffness, S	Maximum 300 MPa @ -12 °C	AASHTO T 313
m-value	Minimum 0.300 @ -12 °C	AASHTO T 313

(d) Asphalt Materials Table Number 4, Grade PG 76-22.

ASPHALT MATERIALS TABLE NO. 4 SPECIFICATIONS FOR PERFORMANCE GRADED ASPHALT BINDER		
Property	**Grade PG 76-22**	
	Specification	Test Method
Original Binder		
Flash Point Temperature	Minimum 230 °C	AASHTO T 48
Rotational Viscosity	Maximum 3 Pa•s @ 135 °C	AASHTO T 316
Dynamic Shear, G*/sin δ	Minimum 1.00 kPa @ 76°C	AASHTO T 315
Rolling Thin Film Oven Residue (AASHTO T 240)		
Mass Loss (RTFO)	Maximum 1.00 %	AASHTO T 240
Dynamic Shear, G*/sin δ	Minimum 2.20 kPa @ 76 °C	AASHTO T 315
Elastic Recovery	Minimum 50 %@ 10°C	AASHTO T 301[1]
Pressure Aging Vessel Residue (AASHTO R 28)		
Dynamic Shear, G*•sin δ	Maximum 5000 kPa @ 26.5 °C	AASHTO T 315
Creep Stiffness, S	Maximum 300 MPa @ -12 °C	AASHTO T 313
m-value	Minimum 0.300 @ -12 °C	AASHTO T 313
[1]The following exceptions shall be made to the requirements given in AASHTO T 301: The statement given in Section 4.5 that reads "Attach the clips to the pins or hooks of the force adapter and the testing machine…" shall be disregarded. The mold shall be in accordance with the requirements given in ASTM D 6084 with dimensions noted in this method. All Elastic Recovery failures will be subject to FTIR scans for acceptability.		

All binders used in Table 4 shall be made by the addition of polymer to refined grades of PG 67-22 without using air blown or oxidized asphalt.

All PG 76-22 shall contain a minimum of 2.5 %, by weight, polymer solids.

A sample and infrared scan (Fourier Transform Infrared, FTIR) using the ALDOT 408 test method to determine the styrene and butadiene peaks along with the percentage of polymer added at the appropriate polymer loading shall be submitted to the Materials and Tests Engineer for laboratory evaluation prior to use. All polymers shall conform to Section 811 for polymer additives.

All Polymer Modified Asphalt Binder manufacturers shall submit the information required in Article 811.01 annually or upon request by the Department.

(e) Asphalt Materials Table Number 5, Emulsified Asphalts.

ASPHALT MATERIALS TABLE NO. 5
SPECIFICATIONS FOR EMULSIFIED ASPHALTS

	VISCOSITY GRADE											
	NTSS-1HM Min-Max	NTQS-1HL Min-Max	CMS-2, CMS-2h, CSS-1, CSS-1h, CRS-2 CRS-2p* CRS-2l*	AE-P Min-Max	CMS-1hp Min-Max	CRS-1h Min-Max	CBC-1HT, BC-1HT Min-Max	CRS-2h CRS-2hp* Min-Max	CQS-1h CQS-1hp* Min-Max	CNTT-1hs Min-Max	AASHTO TESTS
AASHTO M 208			Meet								T 59
Elastic Recovery Minimum 50 % @ 50°F {10°C}	-- --	-- --	50 % for CRS-2p and CRS-2l	-- --	50% --	-- --	-- --	50% for CRS-2hp	50% for CQS-1hp	-- --	T 301 **
Viscosity, Saybolt Furol: @ 77°F {25°C}, Sec @ 122°F {50°C}, Sec	25 500 -- --	-- 100 -- --	-- --	10 50 -- --	30 400 -- --	-- -- 15-100	10 150 -- --	-- -- 200 500	20 150 -- --	0 100 -- --	T 59 T 59 *See Note #4
Settlement, 5 days, %	-- 5	-- --	--	-- 5	-- --	-- --	-- --	-- --	-- --	-- --	T 59
Storage Stability Test 24 hr., %	-- 1.0	-- 1.0	--	-- --	-- 1.0	-- 1.0	-- 1.0	-- 1.0	-- 1.0	1.0 --	T 59
Demulsibility, 35 m/0.8% Sod. Dioctyl Sulfosuccinate, %	-- --	-- --	--	-- --	-- --	-- --	-- --	60 --	-- --	-- --	T 59
Particle Charge	Negative	Non-ionic	Positive	-- --	Positive	Positive	-- --	Positive	Positive	Positive	T 59
Sieve Test, %	-- --	-- 0.10	--	-- 0.10	-- 0.10	-- 0.10	-- 0.30	-- 0.10	-- 0.10	0.10	T 59
Distillation: Oil Distillate or Naphtha, by Volume of Emulsion, % Residue by Distillation, %	-- 1.0 50 --	-- -- 60 --	-- --	-- 12 45 --	-- 3.0 50 --	-- 3.0 55 --	-- 50	-- 3.0 65 --	-- -- 60 --	3.0 -- 50 --	T 59 T 59
Stone Coating Test, % Coated	-- --	-- --	--	-- --	-- --	-- --	-- --	-- --	-- --	-- --	See Note #1
Modified Sand Coating	-- --	-- --	--	-- --	-- --	-- --	-- --	-- --	-- --	-- --	See Note #2
Tests on Residue from Distillation: Float Test @ 140°F {60°C}, Sec. Solubility in CLCH:CCL2, % Ductility @ 77°F {25°C}, cm Ash, % by Mass Specific Gravity, 77°F/ 77°F {25°C/25°C} Softening Point Dynamic Shear@76°C (G*/sinδ, 10rad/s), kPa MSCR@64°C, J_{nr}@3.2/kPa Penetration 77°F {25°C}, 100 g. 5s	-- -- -- -- -- -- -- -- -- -- 65°C -- -- -- -- -- -- 20	-- -- -- -- -- -- -- -- -- -- 60°C -- 1.0 -- -- -- -- 20	-- --	20 -- 97.5 -- -- -- -- -- -- -- -- -- -- -- -- -- -- --	-- -- -- -- -- -- -- -- -- -- 40°C -- -- -- -- -- 45-90	-- -- -- -- -- -- -- -- -- -- 49°C -- -- -- -- -- 40 90	-- -- -- -- -- -- -- -- -- -- -- -- 1.0 -- -- -- -- 2.0	-- -- 97.5 -- 60 -- -- -- -- -- -- -- -- -- -- -- 70 100	-- -- 97.5 -- 40 -- -- -- -- -- -- -- -- -- -- -- 60 110	-- -- -- -- -- -- -- -- -- -- 49°C -- -- -- -- -- 40 90	See Note #3 T 44 T 51 T 111 T 228 T 53 T 315 T 350 T 49

* All CRS-2p, CRS-2hp, CRS-2l, and CQS-1hp shall contain a minimum of 3.0 % polymer by volume. CRS-2p shall meet the requirements given in AASHTO M 316 with the exception of polymer content. All polymers shall conform to the requirements given in Section 811. All Elastic Recovery failures will be subject to FTIR scans for acceptability.
** The following exceptions shall be made to the requirements given in AASHTO T 301: The statement given in Section 4.5 that reads "Attach the clips to the pins or hooks of the force adapter and the testing machine..." shall be disregarded. The mold shall be in accordance with the requirements given in ASTM D 6084 with dimensions noted in this method.

Notes to Asphalt Materials Table No. 5.

NOTE #1. Stone Coating Test.

Use AASHTO T 59, Coating Test, except the mixture of stone and asphalt emulsion shall be mixed vigorously for five minutes and then immediately drenched with approximately twice its own volume of tap water at room temperature after which the aggregate shall be at least 90 percent coated with an asphalt film.

NOTE #2. Modified Sand Coating Test.

Use AASHTO T 59, Coating Test, except a mixture of air-dry test aggregate and asphalt emulsion shall be mixed thoroughly for five minutes then allowed to stand for five hours, after which the mixture shall be capable of being mixed for an additional five minutes. The mixture shall then be drenched with approximately twice its own volume of tap water at room temperature without showing more than 10 percent loss of bituminous film. The test aggregate for use in this test shall be a combination of 90 percent concrete sand and 10 percent Portland cement. The amount of asphalt emulsion used shall be 10 percent by weight {mass} of the aggregate.

NOTE #3. Float Test.

Use AASHTO T 50, with the exception that the residue shall be allowed to cool to room temperature and re-melted at lowest possible temperature that will bring it to a sufficiently fluid condition for easy pouring. Then pour into the collar for completion of the float test.

NOTE #4. Viscosity Test.

If the Viscosity Test begins to drip at 122 °F {50 °C} test temperature, the test shall be repeated at 160 °F {70 °C}. The Viscosity at 160 °F {70 °C} shall not exceed 200 seconds.

(f) Asphalt Materials Table Number 6, Emulsified Petroleum Resin.

ASPHALT MATERIALS TABLE NO. 6
SPECIFICATIONS FOR EMULSIFIED PETROLEUM RESIN

	RESULTS		TEST METHODS	
TESTS	Minimum	Maximum	ASTM	AASHTO
Particle Charge Test	Positive		D 244	T 59
Residue, % * (Residue contains 5% Asphalt)	60	--	D 244	T 59
Sieve Test, % **	--	0.1	D 244	T 59
Viscosity, @ 77 °F {25 °C}, SFS	14	60	D 244	T 59
Tests on Residue:				
Flash Point, COC (°F)	210	---	D 92	T 48
Viscosity at 140 °F {60 °C} (cST)	190	450	D 2170	T 201

* ASTM D 244 Evaporation Test for percent of residue is modified by heating 50 gram sample to 149 °C until foaming ceases, then cooling immediately and calculating results.

** Test procedure identical with ASTM except that distilled water shall be used in place of 2% sodium oleate solution.

SECTION 805
MINERAL FILLER, HYDRATED LIME,CALCIUM CHLORIDE, BRICK, AND BLOCKS

805.01 Mineral Filler, Hydrated Lime, Calcium Chloride, Brick and Blocks.

These minerals shall meet the following requirements:

Mineral Filler	AASHTO M 17
Hydrated Lime	ASTM C 207, Type N.
Calcium Chloride	AASHTO M 144, Type S or L
Sewer Brick	AASHTO M 91, Grade S.M. or M.M.
Building Brick (Clay or Shale)	ASTM C 62, Grade S.W. or M.W.
Concrete Brick (Manholes, etc)	ASTM C 55, Type 11, Grade S
Concrete Brick (Buildings)	ASTM C 55, Type 1, Grade N-I or N-II
Concrete Block (Hollow Load Bearing)	ASTM C 90, Grade N, Type I or II

805.02 Mineral Filler for Hot Mix Asphalt.

These minerals shall consist of finely divided mineral matter such as crusher fines, rock dust, slag dust, hydrated lime, hydraulic cement, Portland cement, loess or Class "F" fly ash meeting the requirements of AASHTO M 17. Any lime based product shall meet the requirements of AASHTO M 303.

SECTION 806
MINERAL ADMIXTURES

806.01 Mineral Admixtures.

(a) General.

The Department has established a list of Mineral Admixtures For Use In Portland Cement Concrete. These products can be found on List I-3 of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

(b) Fly Ash.

Fly ash shall consist of the finely divided residue or ash that remains after burning finely pulverized coal at high temperatures and shall meet the requirements of AASHTO M 295.

(c) Microsilica.

Microsilica for use as a mineral admixture in Portland cement concrete shall meet the requirements of AASHTO M 307.

(d) Ground Granulated Blast Furnace Slag.

Ground granulated blast furnace slag for use as a mineral admixture in Portland cement concrete shall meet the requirements of AASHTO M 302, Grade 100 or 120. The total cementitious material (the ground granulated blast furnace slag and the cement) shall meet the total alkali content requirement in Article 815.07. Additional requirements are given in Section 501.

If ground granulated blast furnace slag is used as a mineral admixture in soil-cement stabilization, the ground granulated blast furnace slag shall meet the requirements of AASHTO M 302, Grade 100 or 120, and the content shall be 50 % of the weight {mass} of the total cementitious material.

SECTION 807
WATER

807.01 Water for Cement Concrete.

(a) Water used in cement concrete shall be fresh, free from oil, and shall not contain impurities in excess of the following limits:

Acidity or alkalinity calculated in terms of calcium carbonate	500 mg/L AASHTO T 26
Total organic solids	500 mg/L AASHTO T 26
Total inorganic solids	500 mg/L AASHTO T 26
Chloride Ion Concentration	250 mg/L AASHTO T 26
Sulfate Ion Concentration	250 mg/L AASHTO T 26
pH	Min. 6.0, Max. 8.0 ASTM D 1293

(b) A comparison of the given water with distilled water can be obtained by making standard soundness, time of setting, and mortar strength tests with standard Ottawa sand, using the same cement of standard quality with each water. Any indication of unsoundness, marked change in time of setting,

or a variation of more than 10 percent in strength from results obtained with mixtures containing the distilled water shall be sufficient cause for rejection of the water under test.

(c) Water from city water supplies may be accepted without being tested.

(d) Water used in curing cement concrete or mortar shall be free from salt or other substance which may be injurious to concrete.

807.02 Water for General Purposes.

This water shall be suitable for the purpose intended and free from substances harmful to the particular work involved.

807.03 Water for Lime Stabilization work.

Water shall be from an approved source, free from any substance which might be harmful to the work, and the total inorganic solids shall not exceed 0.20 percent.

SECTION 808
AIR ENTRAINING ADDITIVES

808.01 Air Entraining Admixtures.

(a) General.

Air entraining admixtures for Portland cement concrete shall comply with AASHTO M 154. These additives shall not contain chloride added during its manufacture.

Air entraining admixtures already approved for use may not be required to meet performance tests; however, new agents not already approved, if deemed necessary, will be required to meet the comparative strength and non-bleeding provisions of AASHTO M 154 modified to require only 3, 7, and 28 day flexural and compressive tests.

(b) Acceptance of Material for Use.

The Department has established a list of Chemical Admixtures For Use In Portland Cement Concrete. These products can be found on List II-1 of the Department’s "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

SECTION 809
CHEMICAL ADMIXTURES FOR CONCRETE

809.01 Chemical Admixtures for Concrete.

(a) General.

Chemical admixtures for concrete shall comply with the requirements of AASHTO M 194 within the following limitations:

These admixtures shall not contain calcium chloride or sugars added during its manufacture. The dosage of each type additive will be included in the concrete design mix issued from the Bureau of Materials and Tests.

When an air entraining admixture is used with a water reducer and/or retarder, both admixtures must be manufactured by the same producer.

(b) Admixture Types.

Type A	Water-reducing admixtures
Type B	Retarding admixtures
Type C	Accelerating admixtures
Type D	Water-reducing and retarding admixtures
Type E	Water-reducing and accelerating admixtures
Type F	Water-reducing, high range admixtures
Type G	Water-reducing, high range, and retarding admixtures

(c) Acceptance of Material for Use.

The Department has established a list of Chemical Admixtures For Use In Portland Cement Concrete. These products can be found on List II-1 of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

SECTION 810
GEOTEXTILES

810.01 Geotextile Filters.

Geotextile filters shall meet the appropriate chemical and physical requirements of AASHTO M 288 for the application for which the material is to be used. The Department has established a list of acceptable Geotextiles. Only the materials on this list shall be furnished for use. This list, List II-3, is given in the "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

Geotextile rolls shall be furnished with a suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

The geotextile shall be formed in widths of not less than 6 feet {2 m}. Sheets of geotextile may be sewn together with thread of a material meeting the chemical requirements given for the plastic yarn to form filter widths as required. The sheets of geotextile shall be sewn together at the point of manufacture or another approved location.

SECTION 811
POLYMER ADDITIVES FOR ASPHALT MATERIALS

811.01 General.

Any polymer not specifically addressed in this Section shall not be used. Variations in composition of polymers listed in this Section will also be considered, if requested in writing to the Materials and Tests Engineer.

The use of any polymer shall require the submittal of a written certification to the Materials and Tests Engineer from the manufacturer showing test results for physical properties of the material including, as a minimum, polymer types, polymer percentages, percentage of any cross linking agent and specific gravity. The manufacturer shall also submit a procedure for incorporating the polymer into the asphalt material for actual production and laboratory blending, which would include blending procedures, desired temperatures, duration of blending, etc. A sample of the bituminous material along with an infrared trace using ALDOT 408 procedure or AASHTO T 302 for emulsions showing the styrene and butadiene peaks and percentage of polymer shall also be submitted by the refinery to the Department for laboratory evaluation prior to use. This submittal shall be made annually or upon request by the Department or if the manufacturer changes polymer sources. Field blends of emulsions shall not require an FTIR trace.

811.02 Styrene Butadiene Rubber (SBR) Latex for Hot Mix Asphalt.

The latex to be used shall be unvulcanized styrene butadiene rubber in liquid latex form. A sample of the asphalt binder at the appropriate polymer loading along with an infrared trace showing the styrene and butadiene peaks shall be submitted to the Department for laboratory evaluation semi-annually or if the manufacturer changes polymer sources. The manufacturer of the SBR latex shall provide a written certification showing test results for total rubber solids, percent styrene and butadiene monomer, ash content, and viscosity. The test results shall comply with the following minimum requirements:

Total Solids, % by weight {mass} (min.)	67
Monomer Ratio Butadiene/Styrene, %	75/25 ± 3
Brookfield, Viscosity, RVT #3 Spindle, 20 rpm	500-2000
Total weight per gallon {mass per liter, kg}	7.7 – 8.0 {3.5 - 3.6}
Total Ash (max.), % of Total Rubber Solids, ASTM D 297	3.5

811.03 SBR Latex for Asphalt Surface Treatments.

The SBR latex to be used shall be an unvulcanized styrene butadiene rubber in liquid latex form. The manufacturer of the SBR latex shall provide a written certification showing test results for total rubber solids, percent styrene and butadiene monomer, ash content, and viscosity. The test results shall comply with the following minimum requirements:

	Cationic CRS-2 Compatible
Total Solids, % by weight {mass} (min.)	60
Monomer Ratio Butadiene/Styrene, %	75/25 ± 3
Brookfield, Viscosity, RVT #3 Spindle, 20 rpm	500-3000
Total Ash (max.), % of Total Rubber Solids, ASTM D 297	3.5

Before beginning the SBR latex rubber surface treatment operation, and as often thereafter as deemed necessary, the Department will check the compatibility of the SBR latex and the asphalt emulsion by using the following procedure:

1. Measure 100 ml of hot asphalt emulsion (160 °F {71 °C}) in beaker.
2. Add 10% of SBR latex to the hot emulsion.
3. Using a stirring rod, mix the contents by hand for a minimum of two minutes. Check for coagulum.
4. Allow to cool to ambient temperature. Note any separation or coagulum.

If the SBR latex-asphalt emulsion is in a smooth liquid state, the materials show compatibility. If the materials coagulate, the Contractor will be required to make any changes necessary, such as lowering the pH of the asphalt emulsion or slightly increasing the surfactant in the asphalt emulsion, to create compatibility of the materials.

The SBR latex-asphalt emulsion shall be used within 24 hours after combining the materials unless special authorization of the Engineer allows otherwise.

811.04 Styrene Butadiene (SB) or Styrene Butadiene Styrene (SBS) for Hot Mix Asphalt.

A sample of the asphalt binder at the appropriate polymer loading, along with an infrared trace using ALDOT 408 showing the styrene and butadiene peaks, along with the percent polymer added shall be submitted to the Department for laboratory evaluation.

SECTION 812
MASONRY STONE

812.01 Masonry Stone.

(a) Type I Masonry Stone.

Stone for coursed and uncoursed rubble masonry shall be of approved quality, sound, durable, and free from segregations, seams, cracks, and other structural defects or imperfections tending to destroy its resistance to stresses and the weather. It shall be free from rounded, worn, or weathered surfaces. All weathered stone shall be rejected. It shall be kept free from dirt, oil, or any other injurious material which may prevent the proper adhesion of the mortar. Unless otherwise provided or shown on the plans, individual stones shall have a thickness of not less than 6 inches {150 mm}. No stone having a horizontal dimension less than 12 inches {300 mm} or less than its thickness shall be used except for filling the interior of the wall.

(b) Type II Masonry Stone.

This stone shall meet the requirements of Type I Masonry Stone above, except that the dimensions of the individual stones shall be 4 to 6 inches {100 to 150 mm} in depth and shall have a reasonably flat top surface of a width not less than 2 inches {50 mm} and length not less than the depth. All stones shall be inspected before and after laying and all rejected material shall be removed immediately from the work.

(c) Type III Masonry Stone.

Stone for rustic masonry shall be rough quarried or field stone of varying sizes and shapes, suitable for the purpose intended and with no attempt made toward squaring or dressing.

SECTION 814
RIPRAP MATERIALS

814.01 Stone.

(a) General.

All stone for riprap shall consist of field stone or rough unhewn quarry stone as nearly rectangular in section as is practicable. When tested as specified in AASHTO T 104, the stone shall show a soundness of not less than 85 percent for 5 cycles, using sodium sulphate, and shall be suitable in all other respects for the purpose intended. It shall have a percentage wear not over 60 percent by the Los Angeles Test, AASHTO T 96, and shall meet the requirements of Article 801.02 for deleterious substances; however, the requirements for deleterious substances may be modified by the Engineer.

Control of the gradation of the various classes of riprap will be by visual inspection either at the source or the project site at the Engineer's option. Any difference of opinion between the Engineer and the Contractor shall be resolved by checking two random truck loads (or equivalent size sample) in accordance with the method provided in ALDOT-239 with all the equipment, labor, and sorting site for this check being provided by the Contractor at his expense.

(b) Class 1 Riprap.

Stone for this class riprap shall consist of graded stones ranging from 10 to 100 pounds {5 to 50 kg} with not more than 10% having a weight {mass} over 100 pounds {50 kg} and at least 50% having a weight {mass} over 50 pounds {25 kg} and not over 10% having a weight {mass} under 10 pounds {5 kg}.

(c) Class 2 Riprap.

Stone for this class riprap shall consist of graded stones ranging from 10 to 200 pounds {5 kg to 100 kg} with not over 10% having a weight {mass} over 200 pounds {100 kg} and at least 50% having a weight {mass} over 80 pounds {40 kg} and not over 10% having a weight {mass} under 10 pounds {5 kg}.

(d) Class 3 Riprap.

Stone for this class riprap shall consist of reasonably well graded stones ranging from 25 pounds to 500 pounds {10 kg to 250 kg} with not over 10% having a weight {mass} over 500 pounds {250 kg}, at least 50% having a weight {mass} over 200 pounds {100 kg} and not more than 15% having a weight {mass} under 25 pounds {10 kg}.

(e) Class 4 Riprap.

Stone for this class riprap shall consist of reasonably well graded stones ranging from 50 to 1000 pounds {25 kg to 450 kg} with not over 25% having a weight {mass} over 1000 pounds {450 kg}, at least 50% having a weight {mass} over 500 pounds {250 kg} and not more than 25% having a weight {mass} under 50 pounds {25 kg}.

(f) Class 5 Riprap.

Stone for this class riprap shall consist of reasonably well graded stones ranging from 2000 pounds {900 kg} and down with not over 10% having a weight {mass} over 2000 pounds {900 kg}, at least 50% having a weight {mass} over 1000 pounds {450 kg} and not more than 25% having a weight {mass} under 200 pounds {100 kg}.

814.02 Concrete Sacked Riprap.

(a) Sacks.

Sacks shall be new, unused, manufactured from jute, cotton, burlap, reinforced paper, or other approved materials capable of holding the cement mixture without significant leakage when handled. The sacks shall be of uniform size and dimension with a capacity of approximately 0.75 cubic feet {0.025m^3}.

(b) Aggregate.

Local sand, gravel, or other designated aggregates shall be from sources approved by the Engineer suitable for the purpose intended.

(c) Cement.

Cement shall meet the requirements of Section 815.

(d) Water.

Water shall meet the requirements of Section 807.

(e) Mixing.

The aggregate and cement shall be formulated by volumetric measure in the proportions of one part cement to four parts sand and five parts gravel or nine parts of bank run gravel, or to designated proportions of other materials, then damp mixed in a concrete mixer using sufficient water to provide for a crumbly consistency.

(f) Prepackaged Concrete Sacked Riprap.

Prepackaged sack riprap which utilizes approved bagging material and a dry mixture of predried sand-cement material may be substituted for the concrete sacked riprap noted in this Article provided (1) the source or prepackaging operation has been approved by the Materials and Tests Engineer, (2) the packing material is permeable and absorptive enough to permit passage of sufficient water to provide for hydration of the cement, (3) the sand and cement materials are from sources acceptable to the Materials and Tests Engineer, (4) the sand and cement are dry mixed in the proportions of 5 cubic feet {0.14 m^3} of sand to one bag of cement until uniform in color, (6) packaging, handling, and storage shall be such as to prevent damage to the prepackaged material, especially from collecting excess moisture until placed.

814.03 Filter Blanket.

(a) General.

Filter blanket material shall consist of a blanket of aggregate or geotextile blanket placed under a riprap material.

(b) Aggregate Blanket.

An aggregate blanket may be either gravel or crushed stone ALDOT Size No. 467 aggregate, unless otherwise shown on the plans, reasonably free from flat or elongated pieces and from organic or soft friable particles in objectionable quantities.

(c) Geotextile Blanket.

The geotextile shall meet the requirements of AASHTO M 288 for Permanent Erosion Control Geotextile and Section 810 of these specifications.

SECTION 815
CEMENT

815.01 Type I Portland Cement.

Type I Portland Cement shall meet the requirements of AASHTO M 85 and the additional requirements shown below.

815.02 Type II Portland Cement.

Type II Portland Cement shall meet the requirements of AASHTO M 85 and the additional requirements shown below.

815.03 Type III Portland Cement (High Early Strength).

Type III Portland Cement shall meet the requirements of AASHTO M 85 and the additional requirements shown below.

815.04 Type IS Portland Blast Furnace Slag Cement.

Type IS Portland blast furnace slag cement shall meet the requirements of AASHTO M 240, Blended Hydraulic Cement.

815.05 Type IL Portland Limestone Cement.

Type IL Portland limestone cement shall meet the requirements of AASHTO M 240, Blended Hydraulic Cement.

815.06 Masonry Cement.

Masonry cement shall meet the requirements of ASTM C 91.

815.07 Chemical Properties.

The Specifications for all cements as covered by Articles 815.01 to 815.06, inclusive, are amended to the effect that the total alkali content of any cement used, calculated as the percentage of sodium oxide (Na_2O) plus the product of 0.658 times the percentage of potassium oxide (K_2O), shall not exceed 0.60 percent.

In addition to the above, for Type II cement covered by Article 815.02, the standard chemical requirement shown in Table 1 of AASHTO M 85 for Tricalcium Silicate (C_3S) is hereby waived.

815.08 Testing of Cement.

All cement furnished for use shall be tested before use or be from an approved producer meeting the requirements of ALDOT-227, Quality Control of Portland and Blended Hydraulic Cements, and listed on List I-2, PRODUCERS OF PORTLAND AND BLENDED CEMENT, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

815.09 Flash Set and False Set.

Flash set and false set, as determined by ASTM C 451, shall be cause for rejection of the cement.

815.10 Unusual Appearance.

Unusual appearance as to color, etc. shall be sufficient grounds for rejection of the cement.

815.11 Use, Care, and Handling.

(a) Use.

1. Bulk cement will be permitted provided the bulk cement is handled as follows:

   a. Portland cement shall be measured by weight {mass}, considering that one bag of cement is equivalent to 94 pounds {42 kg} net of cement.

   b. Handling equipment and the equipment used for weight {mass} determination shall be inspected by the Engineer prior to use. Cement shall be fully protected from contamination or damage during handling.

   c. Bulk cement shall be batched by weight {mass}, and scales may be of either the beam or springless dial type and shall be the product of a reputable manufacturer. Scales shall be accurate to within a tolerance of 5 pounds per 1000 pounds {2 kg per 455 kg} net load in the hopper. The value of the minimum gradation of any scale shall not be greater than 0.1 percent of the scale capacity.

d. Provisions shall be made to indicate to the operator that the required load in the hopper or container is being approached, such as a springless dial indicator or tare beam. Such device shall indicate at least the last 50 pounds {22 kg} of load.

e. After the required weight {mass} of the cement is batched, it shall be protected from loss in handling or in transit.

2. Only cement of the same "Type" shall be used in the construction of any structure or unit (substructure or superstructure) except as permitted in writing. All cement in any container having lumps of cement or caked cement, or cement which for any reason has become damaged or partially set, shall be rejected. Cement salvaged from discarded or used bags shall not be used. Cement shall not be used while its temperature is more than 150 °F {65 °C}.

3. The Contractor shall keep accurate records of the deliveries of cement and its use in the work including that from ready-mix plants. Copies of these records shall be furnished the Engineer at the close of each day's work or 8 hour run, in such form as he may require, showing the quantity used during the day or run at each part of the work.

(b) Care and Handling.

1. The Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement not for immediate use shall be stored in suitable weather proof buildings. Buildings shall be placed in approved locations. Provisions for storage shall be ample and the shipment of cement as received shall be separately stored in such a manner as to provide easy access for identification and inspection of each shipment. On small structures, storage in the open may be permitted by authorization, in which case a raised platform and ample waterproof covering shall be provided. Stored cement shall meet the test requirements at any time after storage when a retest is ordered.

2. Cement of different types, even if tested and approved, shall be stored separately and shall not be mixed.

SECTION 817
LIME FOR ROADBED AND BASE STABILIZATION

817.01 Hydrated Lime.

Hydrated lime shall be high calcium (Type 1) and shall conform to AASHTO M 216 when tested in accordance with AASHTO T 219.

Hydrated lime shall be stored and handled in water-proof containers until immediately before distribution to the road. If storage bins are used, they shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness.

817.02 Quicklime.

Quicklime shall meet the requirements of AASHTO M 216 after hydration in the laboratory.

When quicklime is to be applied directly to the roadbed, the following additional requirements shall apply:

Sieve	% Passing by Weight {Mass}
3/4 inch {19.0 mm}	100
1/2 inch {12.5 mm}	30 - 80
No. 4 {4.75 mm}	0 - 10

Quicklime shall be handled and stored in waterproof containers until used. Accidental contact with water shall be avoided.

SECTION 820
SELECTED MATERIALS FOR BASES

820.01 Description.

Selected materials for the purpose of these specifications shall be of the kind and general character of sand-clay, chert, clay-gravel, sand, local stone, stone screenings, etc., or combinations thereof, with or without commercial aggregate meeting the requirements noted in this Section.

820.02 General Requirements.

(a) General.

The material shall meet the general requirements for the respective material noted in this Article and the special and specific requirements noted in Article 820.03.

The following terms are defined for general use.

Artificial Mixture. The term "Artificial Mixture" is defined as a mixture, resulting from combining as indicated on the plans or as directed, of two or more base course materials, including binder soils suitable for the purpose intended and sands of the same or different kind generally from separate sources.

Coarse Aggregate and Binder Soil (Binder). The coarse aggregate for base courses shall be all material retained on the No. 8 {2.36 mm} sieve; binder shall be all materials passing the No. 8 {2.36 mm} sieve.

Blends. Blends shall be an artificial mixture of (1) two or more materials of the kind and/or character described in this Section or similar materials; (2) one or more soils plus stabilizer aggregate or either local stone, commercial coarse aggregate meeting the provisions of Section 801 with size number designated on the plans, or processed reef shell meeting provisions of Section 827.

(b) Sand Clay.

Sand clay shall be a natural material or artificial mixture, consisting largely of a mixture of sand and clay in proper proportions, that occurs in natural deposits of varying depths or a blended mixture of sand and clay.

(c) Chert.

Chert shall be a metamorphic, fragmentary, flint or silica formation interspersed with varying quantity and quality of clay binder. Chert in its natural formation may require blasting to facilitate loading and manipulation.

(d) Clay Gravel.

Clay gravel shall be composed of gravel and sand with clay binder. The coarse aggregate (gravel) shall be clean, hard, tough, durable, and reasonably free from thin, elongated, soft, or laminated pieces. The binder, consisting of material passing the No. 8 {2.36 mm} sieve, shall be a good grade of sand clay or other approved material. Clay gravel in its natural formation may require blasting to facilitate loading and manipulation.

(e) Local Sand.

Local sand shall consist of grains of hard, sound material, predominantly quartz or other hard, durable rock, including friable, loosely bound deposits of sandstone conglomerate normally found in natural deposits in the project vicinity.

(f) Local Sand-Gravel.

Local sand-gravel shall be hard, sound, durable rock, including friable, loosely bound sand-stone conglomerate, with varying amounts of coarse aggregate and sand normally found in natural deposits in the project vicinity. The coarse aggregate and the sand shall be free from a coating of injurious material, lumps of clay, loam, organic matter, or other foreign material. If necessary, gradation and/or other requirements will be provided in the plans and/or proposal form.

(g) Local Stone.

Approved local source-run stone shall consist of tough, durable fragments and sand, clay, or other binder type materials. If necessary, gradation and/or other requirements will be provided in the plans or proposal.

(h) Commercial Aggregates.

Commercial aggregates shall meet the appropriate requirements of Sections 801 and 802.

(i) Stone Screenings.

Stone screenings shall consist of crushed stone fragments, all passing the No. 4 {4.75 mm} sieve with the fines down to and including dust, but not more than 30 percent by weight {mass}, passing the No. 100 {150 µm} sieve. The stone shall meet the general requirements of Section 801.

(j) Pond Ash.

Pond ash shall consist of a combination of bottom ash and fly ash produced as a by-product of burning coal.

820.03 Specific Requirements.

General COMPOSITION					
Sieve Requirements	Percentage Passing By Weight {Mass}				
	TYPE				
	A	A-1	B	B-1	C*
3 inch {75 mm}	100	100	100	100	100
No. 8 {2.36 mm}	60-100	42-100	22-75	20-70	20-50
No. 200 {75 μm}	7-45	5-45	3-38	3-46	3-35
Liquid Limit (LL)	28 Max.	35 Max.	28 Max.	35 Max.	45 Max.
Plasticity Index (PI)	8 Max.	15 Max.	8 Max.	15 Max.	20 Max.
* CBR of 40 + with swell of less than 5%					

Material placed on the road found not meeting the above requirements may in lieu of removal and replacement be stabilized with approved materials in such proportions that the finished layer will meet the above specified requirements.

SECTION 821
GRANULAR SOIL MATERIALS

821.01 Description.

Granular Soil for the purpose of these Specifications shall be of the kind and general character of sand-clay, topsoil, sand, soft sand rock, etc., or combinations thereof meeting the requirements noted in this Section.

821.02 General Requirements.

(a) General.

The material shall meet the general requirements for the respective material noted in this Article and the specific requirements noted in Article 821.03.

Reference is made to Subarticle 820.02(a) for definition of terms for coarse aggregate, binder, artificial mixture, and blends.

(b) Sand Clay.

See Subarticle 820.02(b).

(c) Topsoil Base Material.

Topsoil base material shall consist of a natural material or artificial mixture, sometimes pebbly in character, that occurs in surface deposits of limited depth and in general on elevated areas.

(d) Foundry Sand.

Foundry sand shall be a waste material consisting of burned sand with or without slag fragments. In general, this material is waste or by-product material from foundry operations.

(e) Soft Sand Rock.

Soft sand rock shall be a friable natural material, generally sandy in character and occurring as a partially disintegrated sandstone with occasional hard strata, in sub surface formations of varying thickness and in general on elevated areas.

Blasting is usually required to facilitate loading with power shovels. Pulverizing by use of rollers, tractors, or other equipment is usually necessary.

(f) Local Sand.

See Subarticle 820.02(e).

821.03 Specific Requirements.

General COMPOSITION			
Sieve Requirements	Percentage Passing By Weight {Mass}		
	TYPE		
	A	B	C
2 inch {50 mm}	100	100	100
No. 8 {2.36 mm}	20-100	20-100	20-100
No. 10 {2.00 mm}	19-100	18-99	18-95
No. 40 {425 µm}	10-100	8-95	6-65
No. 200 {75 µm}	2-45	2-40	2-35
Clay	2-18	1-18	1-16
Liquid Limit (LL)	25 Max.	25 Max.	25 Max.
Plasticity Index (PI)	6 Max.	6 Max.	6 Max.

Material placed on the road found not meeting the above requirements may, in lieu of removal and replacement, be stabilized with approved materials in such proportions that the finished layer will meet the above specified requirements.

SECTION 822
DRAINAGE PLANE MATERIALS

822.01 General.

Drainage plane material shall, unless otherwise specified by plan details, be restricted to ALDOT Sizes 57, 67, 68 or 78 conforming to the requirements of Section 801 modified to require a minimum permeability of 50 mm/sec. as determined by the Constant Head Permeameter Test.

Each material source will be pretested for permeability before shipments of material to the project are begun, and after approval no further permeability tests will be required provided there are no significant changes in the characteristics of the material noted; however, continuing gradation tests of the material will be made.

SECTION 823
SOIL AGGREGATE MATERIALS

823.01 Description.

Soil Aggregate for the purpose of these Specifications is classified according to the several kinds and general characteristics set forth in this Section.

823.02 General Requirements.

(a) General.

The material shall meet the general requirements noted in this Article and the specific requirements noted in Article 823.03.

Reference is made to Subarticle 820.02(a) for definitions of terms, coarse aggregate, binder, artificial mixture and blends.

(b) Clay Gravel.

See Subarticle 820.02(d).

(c) Clay Gravel-Sand.

Clay gravel-sand shall meet the general requirements provided in Subarticle 823.02(b) for clay gravel, except that it is an artificial mixture composed of clay gravel and sand.

(d) Chert.

See Subarticle 820.02(c).

(e) Chert-Sand Mixture.

Chert-sand shall meet the same general requirements provided in the Subarticle 820.02(c) for chert, except that it is an artificial mixture composed of chert and sand.

(f) Float Gravel.

Float gravel shall be a varying stream deposit of worn and weathered coarse aggregate containing varying amounts of sand and soil. Oversized rock and boulders are frequently encountered and require reduction in size if used or elimination from the desired material. If provided by the plans, sand or binder soil shall be combined to provide for an artificial mixture.

(g) Industrial Waste.

Industrial waste shall be a mixture of foundry sand and fragments of slag or other materials of a durable nature. This is a waste material occurring as a result of processing iron and steel, and due to chemical actions therein, the stockpile must be approved by the Materials and Tests Engineer before it may be used.

(h) Red Dog-Sand.

Red Dog-sand is an artificial mixture of red dog and sand. Red dog (or red ash) is a burned waste material from mining or industrial operations, and in general is a fragmentary, tile-like material with varying amounts of binder and fines which will not be permitted unless specified on the plans or in the proposal.

(i) Soft Sand Rock - Any Aggregate.

Soft sand rock - any aggregate shall be an artificial mixture consisting of soft sand rock as defined by Subarticle 821.02(e) combined with (1) any aggregate or (2) other base materials which in general is predominantly coarse aggregate.

(j) Stone, Gravel and Slag Aggregate.

Stone, gravel, and slag aggregate shall meet the general requirements provided by Articles 801.03, 801.04, and 801.05 respectively. This classification is an artificial mixture of stone, gravel, or slag aggregate and (1) binder soil, or (2) clay gravel, chert, float gravel, or other natural soil-aggregate material.

(k) Limerock.

Limerock shall be crushed or processed as a part of the mining operations. Limerock shall not have chert or other deleterious substances. Limerock shall have a carbonate (calcium or magnesium) content of at least 90 %. At least 97 % (by weight) of the material shall pass a 3.5 inch sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust of fracture. The liquid limit shall not exceed 35 and the crushed limerock material shall be non-plastic. Limerock shall have an LBR of at least 100 % according to ALDOT-427 "Procedure for Limerock Bearing Ratio." Producers of Limerock shall participate in ALDOT-249, "Procedure for Acceptance of Fine and Coarse Aggregates."

823.03 Specific Requirements.

GENERAL COMPOSITION			
Sieve Requirements	Percentage Passing By Weight {Mass}		
	TYPE		
	A	B	C
2.5 inches {63 mm}		100	100
2 inches {50 mm}	100	85-100	85-100
1 inch {25.0 mm}	85-100	50-100	50-100
3/4 inch {19.0 mm}			35-95
No. 4 {4.75 mm}	50-85	30-75	25-58*
No. 8 {2.36 mm}	35-75	25-70	22-50
No. 10 {2.00 mm}	30-74	22-69	20-49
No 40 {425 µm}	12-68	6-67	6-48
No. 200 {75 µm}	4-28	3-29	3-23
Clay	2-15	2-14	2-12
Liquid Limit (LL)	26 Max.	26 Max.	26 Max.
Plasticity Index (PI)	6 Max.	6 Max.	6 Max.
* Retained portion must contain a minimum of 25% crushed particles.			

Material placed on the road found not meeting the above requirements, may in lieu of removal and replacement, be stabilized with approved materials in such proportions that the finished base will meet the above requirements.

SECTION 824
PROCESSED REEF SHELL BASE MATERIALS

824.01 Description.

Processed Reef Shell Base for the purpose of these Specifications is classified as a composite base course material which contains a large percentage of Processed Reef Shell blended with portions of Selected Soil, Granular Soil, Soil Aggregate, or other approved materials.

824.02 General Requirements.

Processed Reef Shell furnished for use shall comply with the requirements of Article 827.02 and, when combined with other material, shall produce the material complying with the designated type noted in the specific requirements provided in Article 824.03.

Gradation may be obtained by the proper blending of local or other commercial materials and approximately 40% of reef shell by weight {mass} for Type A and approximately 60% reef shell by weight {mass} for Type B.

Special note is made of the fact that, should the gradation run on the extreme fine or coarse side, difficulty can be expected in obtaining the modified proctor density.

824.03 Specific Requirements.

GENERAL COMPOSITION		
Sieve Requirements	Percentage Passing By Weight {Mass}	
	TYPE	
	A	B
2.5 inches {63 mm}		100
2 inches {50 mm}	100	85-100
1 inch {25.0 mm}	70-100	50-100
3/4 inch {19.0 mm}		40-95
No. 4 {4.75 mm}		25-65*
No. 8 {2.36 mm}	40-70*	20-55
No. 10 {2.00 mm}	38-66	18-53
No 40 {425 µm}		5-52
No. 200 {75 µm}	4-28	2-22
Clay		10 Max.
Liquid Limit (LL)	30 Max.	26 Max.
Plasticity Index (PI)	10 Max.	6 Max.
* NOTE: Retained portion must contain at least 75% shell particles.		

SECTION 825
CRUSHED AGGREGATE BASE MATERIALS

825.01 Description.

Crushed Aggregate Base for the purpose of these Specifications shall consist of 100 percent crushed stone conforming to the requirements noted in this Section.

825.02 General Requirements.

The crushed stone furnished for use shall conform to the general requirements of Section 801 and the specific requirements noted in Article 825.03. Gradation analysis will be performed in accordance with AASHTO T 27.

Gradation may be obtained by the proper mixing of certain regular ALDOT size aggregates as noted below; however, no specific gradation will be required prior to mixing operations.

Type A - Approximately 75% ALDOT No. 610 with Approximately 25% ALDOT No. 8910.

Type B - Approximately 50% ALDOT No. 410 with Approximately 50% ALDOT No. 810.

825.03 Specific Requirements.

GENERAL COMPOSITION		
Sieve Requirements	Percentage Passing By Weight {Mass}	
	TYPE	
	A *	B **
2 inches {50 mm}		100
1.5 inches {37.5 mm}		90-100
1 inch {25.0 mm}	100	75-98
3/4 inch {19.0 mm}	86-100	- - -
1/2 inch {12.5 mm}	- - -	55-80
No. 4 {4.75 mm}	26-55	40-70
No. 8 {2.36 mm}	15-41	28-54
No. 16 {1.18 mm}	- - -	19-42
No. 50 {300 µm}	3-18	9-32
No. 200 {75 µm}	5-15	7-18
* The fraction passing the No. 40 {425 µm} sieve shall not have a liquid limit in excess of 25. ** The fraction passing the No. 40 {425 µm} sieve shall not have a P.I. in excess of 6 nor a L.L. in excess of 25, and contain not more than 2/3 by weight {mass} passing the No. 200 {75 µm} sieve.		

SECTION 826
LOCAL SAND AND SAND-GRAVEL FOR MISCELLANEOUS CONSTRUCTION USE

826.01 Description.

Local materials, for the purpose of these Specifications, shall be of the kind and character of local sand and local sand-gravel or blends thereof.

826.02 General Requirements.

(a) General.

The kind of material shall meet the general requirements for the respective classification of material as noted in this Article.

Blends shall consist of any combinations of local sand or sands, or local sand-gravel, or sand-gravels. All blends shall be of the material proportions or ratio provided by the plans and/or proposal.

When used in bituminous pavements, local source material shall be non-plastic.

(b) Local Sand.

Local sand shall be pit-run sand suitable for the purpose intended. In general, all local sand shall consist of grains of hard, sound material, predominantly quartz or other hard, durable rock, including friable, loosely bound deposits of sandstone conglomerate. The sand shall be free from a coating of injurious material, lumps of clay, loam, organic matter, or other foreign material.

If necessary, gradation and/or other requirements will be provided in the plans and/or proposal form.

(c) Local Sand-Gravel.

Local sand-gravel shall be pit-run sand-gravel, suitable for the purpose intended. In general, the sand-gravel shall be hard, sound durable rock, including friable, loosely bound sandstone conglomerate, with varying amounts of coarse aggregate and sand. The coarse aggregate and the sand shall be free from a coating of injurious material, lumps of clay, loam, organic matter, or other foreign material. If necessary, gradation and/or other requirements will be provided in the plans and/or proposal form.

SECTION 827
PROCESSED REEF SHELL

827.01 Description.

Processed Reef Shell shall consist of dead reef shells (oyster, clam, or other dead shell as encountered in the reef) but not cannery or live shell. Processing shall consist of washing the shell by the use of a screen washer, the mesh of which shall not be smaller than 1/4 of an inch {7 mm}.

The processed shell shall be classified as a commercial aggregate.

827.02 Processed Shell For Soil Or Aggregate Base Courses.

Processed shell used in base courses shall, after processing, not contain foreign matter in excess of three percent when washed over a No. 200 {75 µm} sieve of the dry weight {mass} of the shell.

827.03 Processed Shell For Bituminous Bases and Pavements.

Processed shell used in bituminous work shall in addition to the requirements noted in Articles 827.01 and 827.02 require the oversize fraction to be crushed in a mechanical crusher and rescreened.

SECTION 830
CONCRETE CURING MATERIALS

830.01 Burlap Cloth and Waterproof Covering Material.

(a) General.

Burlap cloth and waterproof covering material shall be of sufficient length and width to extend beyond the edge of the concrete a distance of at least twice the thickness of the slab. Sections of covering material shall be lapped at least 18 inches {450 mm}. The surface and both sides of a concrete slab shall be completely covered. The covering shall be so placed and secured as to cause it to remain in total contact with the exposed surface. Burlap cloth shall be saturated with water before being placed and shall be kept wet while in position. The covering shall remain in position for six days after the concrete has been placed unless otherwise specified or directed.

(b) Types of Covering Material.

1. Burlap cloth shall conform to the requirements of AASHTO M 182 for Class 4 burlap.
2. White Waterproof Paper shall conform to the requirements of ASTM C 171.
3. Polyethylene sheeting (film) shall be white opaque conforming to the requirements of ASTM C 171 modified to omit the elongation requirements when the sheeting is internally reinforced with a cord net having a cord spacing of 1/4 to 1/2 of an inch {6 to 13 mm}. (Net may be nylon or other approved material.)
4. White Burlap Polyethylene sheet shall conform to the requirements of ASTM C 171.

830.02 Impervious Membrane.

Impervious membrane compounds shall meet the requirements of ASTM C 309, Class A. Type 2 white pigmented shall be used on concrete pavement. Other types may be used on other concrete.

Membrane liquid shall be applied under pressure with spray nozzles in such a manner as to cover the area being treated with a uniform film. For concrete pavement the rate of application shall be 1 gallon {4 L} to not more than 135 square feet {13 m^2}, applied in two applications. For sidewalks the rate of application shall be 1 gallon {4 L} to not more than 200 square feet {19 m^2}.

830.03 Wetted Earth Or Sand.

When this type of curing is used, the pavement shall be cured initially with burlap cloth, polyethylene sheets, or waterproof paper, as specified in Article 830.01, until after final set of the concrete or, in any case, for 12 hours after placing the concrete. As soon as the covering material is removed, the surfaces and sides of the pavement shall be covered with a blanket of earth or sand not less than 2 inches {50 mm} thick. If the earth or sand covering becomes displaced during the curing period, it shall be replaced to the original depth and saturated with water for three days and thoroughly wetted down during the morning of the fourth day; the cover shall remain in place until the concrete

has attained the required strength. When permission is given to open the pavement to traffic, the covering material shall be removed and the pavement cleaned and swept.

Earth or sand used in this method of curing shall be free of sticks, stones, or other matter which might injure the surface of the concrete. The material shall contain no ingredients which would be detrimental to the concrete or discolor the surface finish.

830.04 Straw.

Straw used as a supplement to the curing materials noted in Article 830.01 and 830.02 for cold weather protection shall be suitable for the purpose intended and approved each time it is used.

SECTION 831
PRECAST CONCRETE PRODUCTS

831.01 Description.

All precast concrete products, except precast non-prestressed concrete bridge members, shall be furnished from an approved producer that is participating in, and meeting the requirements given in ALDOT-364. ALDOT 364 is the "Procedure for Inspection of Concrete Pipe, Precast Manholes, Precast Box Culverts, and Miscellaneous Precast Concrete Products".

Producers of precast concrete products shall be shown in List I-8, PRODUCERS OF PRE-CAST CONCRETE PRODUCTS, of the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" Manual. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

SECTION 832
CONCRETE JOINT FILLERS, JOINT AND CRACKSEALANTS, AND WATERSTOP MATERIALS

832.01 Preformed Joint Filler.

(a) General.

Preformed joint filler units shall be furnished in one piece of the length, thickness, and depth shown on the plans for a complete joint, unless otherwise authorized by the Engineer. When the use of more than one piece is authorized, the abutting ends shall be fastened securely and held accurately in place to correct shape by stapling or other satisfactory means.

When a preformed filler is used with dowels or other protruding items which must pass through the filler, clean-cut holes, accurately spaced and not more than 1/8 of an inch {3 mm} larger than the protruding item shall be provided.

Damaged filler units shall be rejected.

Joint fillers used in conjunction with expansion joints will require the use of a joint sealer in order to provide a functional joint. Sealants shall be one of the appropriate types specified in Article 832.02 or Subarticle 832.03(a), unless a specific type is specified by the plans.

(b) Filler for Construction Joints in Bridge, Culvert, and Drainage Structures.

Preformed bituminous joint filler for general use in bridge, culvert, and drainage structure work shall meet the requirements for one of the following "Types" unless a specific "Type" is required by the detailed plans:

Type 1 - AASHTO M 33

Type 2 - AASHTO M 213, modified to allow a maximum of 25% water absorption.

(c) Expansion Joint Filler.

Expansion joint filler for concrete pavement, curb, gutter, combination curb and gutter, flumes, slope paving, and other miscellaneous concrete structures shall meet the requirements as given for one of the following materials:

1. AASHTO M 153,
2. AASHTO M 213 modified to allow a maximum of 25% water absorption, or

3. ASTM D8139.

832.02 Joint and Crack Sealants.

(a) General.

Joint and crack sealants may be used for sealing both expansion joints and construction joints in concrete units other than bridges within the following limitations:

Vertical joints in concrete units such as curbs, etc. will require the use of a non-sag compound.

Construction joints 1/4 of an inch {6 mm} or less in width will not require sealing unless specified by plan details.

The shape factor of joint sealant is most important. The joint configuration shown by the plan details may require the use of a backer rod or strip to insure proper shape. When a backer rod or strip is necessary, it shall be compatible with the sealant and shall have no bond or reaction between the sealant and the backer rod or strip. A bond breaking tape may be used to insure no bond occurs between the two materials.

Requirements for joint and crack sealants are noted in the following Subarticles; however, the Contractor may substitute an approved preformed elastomeric seal meeting the requirements of Subarticle 832.03(a) in lieu of a sealer provided such is furnished at no additional cost to the Department.

A certified test report showing actual test results shall be furnished with each lot of joint sealer furnished to each project. Each lot of sealant shall be delivered in containers plainly marked with manufacturer's name or trade mark, type of sealant, lot number, and date of manufacture. The Department may run any or all tests deemed necessary.

(b) Hot Applied Joint and Crack Sealant.

Hot Applied Joint and Crack Sealant shall meet the requirements of AASHTO M 324 (ASTM D 6690) for Type I Sealant, or Type II Sealant. Hot Applied Joint Sealant shall be selected from the Department's LIST III-4, "Joint and Crack Sealants". Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

(c) Cold Applied Joint and Crack Sealant.

Cold Applied Joint and Crack Sealant shall be a resilient adhesive compound capable of effectively sealing joints from infiltration of incompressible materials and water throughout repeated contraction and expansion cycles.

The sealant, when delivered, shall be capable of being used on the job site and may be placed by machine, pressure gun, or by hand. The compound, when used in other than horizontal joints, shall be capable of conforming to the slope face without sagging.

Cold Applied Joint Sealant shall be selected from the Department's LIST III-4, "Joint and Crack Sealants". Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

The sealant shall be a homogeneous blend of materials, which may or may not require a primer. The sealant shall meet the requirements given in ASTM D 5893.

832.03 Preformed Elastomeric Joint Seals.

(a) Compression Seals.

1. General.

Compression type elastomeric seals shall consist of an approved seal shape formed from elastomeric material, designed to be installed and function in a compressed state. Installation of this type seal requires the use of a lubricant adhesive. This type seal when used on bridge decks will not require the use of a joint filler material unless such is specified by plan details.

2. Materials.

Materials used in fabricating the preformed elastomeric seals shall conform to the requirements of ASTM D 2628 for Concrete Pavement and ASTM D 3542 for Bridges and be of the basic shape, dimension, etc. shown by the plan details. No factory or field splicing of seals in transverse joints 50 feet {15 m} or shorter in length will be allowed. On transverse joints over 50 feet {15 m} in length, one field splice will be considered for approval by the Engineer pending written request from the Contractor. This request shall specify the materials and details of performing the splice. Since the intent is to have one continuous seal meeting the above requirements, absolutely no patching of torn or damaged spots in the seal shall be permitted.

In addition to the above, seals for bridge joints (including the joint between the bridge end and the bridge end slab) shall have a depth to width ratio of not less than 1 ($D/W \geq 1$).

The lubricant adhesive used in installing the compression seals in joints shall meet the requirements of ASTM D 2835 for concrete pavement and ASTM D 4070 for bridge joints.

3. Construction Method.

The installation of the seal shall be in accordance with the manufacturer's recommendation, plan details, approved shop drawings, and the following:

a. Sand blast and clean all surfaces of the joint with steel areas cleaned to a "Near White" classification.

b. Prepare joint lubricant adhesive compound and apply to joint.

c. Place sealer without stretching beyond a maximum of five percent elongation.

(b) Diaphragm Type Seals

1. Flexible, Unreinforced Elastomeric Type Seal.

a. General.

This type seal shall consist of an approved seal shape formed from elastomeric material without metal reinforcement, anchored by mechanical or other acceptable methods to anchor plates cast into or affixed to the joint edges.

b. Materials.

The elastomeric material shall conform to the requirements of ASTM D 2628 modified to omit the recovery tests, with or without fiber or other types of acceptable non-metallic reinforcement. The seal shall be of the basic shape and dimensions shown by plan details unless otherwise authorized in writing by the Bridge Engineer.

Metal anchor plates shall conform to the requirements of ASTM A 36 or equivalent.

Any sealant or lubricant shall conform to the requirements for lubricant adhesive noted in Subarticle 832.03(a) or an approved equivalent.

c. Construction Methods.

The installation of the seal shall be in accordance with the manufacturer's recommendations, the plan details, and the approved shop drawings.

2. Flexible, Reinforced Elastomeric Type Seal.

a. General.

This type seal shall consist of an approved shape formed from elastomeric material reinforced internally with metal strips with the seal affixed to the bridge deck by the method indicated in the plan details.

b. Materials.

The elastomeric material used in the seal shall conform to the following:

ELASTOMERIC SEAL SPECIFICATIONS		
TEST	REQUIREMENT	TEST METHOD
Hardness, Durometer A	45 ± 5	ASTM D 2240
Tensile Strength	1800 psi {12.5 Mpa}, Min.	ASTM D 412
Elongation @ break	400% Min.	
Compression Set, 22 hrs. @ 158 °F {70 °C}	20% Max.	ASTM D 395 Method B
Low Temperature	Not Brittle @-40 °C	ASTM D 746
Ozone Resistance, Exposure to 100 ppm {100 mg/l} Ozone for 70 hrs. @ 100 °F {38 °C} Sample under 20% Strain	No Cracks	ASTM D 1149
Oil Deterioration Volume increase after immersion in ASTM Oil #3 for 70 hrs. @ 212 °F {100 °C}	120% Max.	ASTM D 471
Flame Resistance	Will Not propagate flame	ASTM C 542
Reinforcement		ASTM A 36 or equivalent

Sealant shall conform to lubricant adhesive in Subarticle (a) or an approved equivalent.

c. Construction Method.

Installation of the seal shall be in accordance with the manufacturer's recommendations in the plan details and the approved shop drawings.

832.04 Blank.

832.05 Waterstop Materials.

(a) Description.

Waterstops shall be of the size and shape shown on the plans. The material may be either neoprene, polyvinylchloride or strip applied expandable waterstop meeting the requirements given in this Section.

(b) Neoprene.

Physical Requirements.

1. Tensile Strength, Method A using die C – 2000 psi {13.78 MPa} Min., ASTM D 412.
2. Ultimate Elongation, Method A using die C – 360 % Min., ASTM D 412.
3. Type A Shore Durometer Hardness - 65 ± 5, ASTM D 2240.
4. Change in Type A Durometer Hardness, 70 hrs. heat aged @ 158 °F {70 °C} + 15 points Max., ASTM D 2240.
5. Compression Set, Method B, Max permissible change after 22 hrs. heat aged @ 158 °F {70 °C} 30%, ASTM D 395.

(c) Polyvinylchloride.

Physical Requirements.

1. Tensile Strength, Method A using die C – 1750 psi {12.17 MPa} Min., ASTM D 412.
2. Ultimate Elongation, Method A using die C – 300 % Min., ASTM D 412.
3. Type A Shore Durometer Hardness 80 ± 5 ASTM D 2240.
4. Change in Type A Durometer Hardness, 70 hrs. heat aged @ 158 °F {70 °C} + 15 points Max., ASTM D 2240.

(d) Strip Applied Expandable Waterstop.

Physical Requirements.

1. Specific Gravity – 130-160 , ASTM D 71.
2. Penetration - cone at 77 °F, 150 gm, 5 sec, 40 mm ± 5, ASTM D 217.
3. Volatile Matter – 1 % Max., ASTM D 6.

832.06 Drainage Trough Material for Open Type Expansion Dam Units.

Drainage trough material furnished for use shall be a high grade neoprene reinforced with at least two layers of flexible polyester or nylon cord fabric acceptable to the Engineer meeting the following requirements.

1. Fabric reinforcement shall be a close woven material providing equal strength in both warp and fill directions.
2. The finished product shall be of the shape, size, and thickness shown by the plan details meeting the following test:

   Oil Deterioration - Maximum weight {mass} change of 55% after immersion in IRM Oil 903 for 70 hours at 212 °F {100 °C} - ASTM D 471.

3. Only minimum splicing across the width of the required material will be allowed. Any splice allowed must be performed using materials and in a manner recommended by the producer of the material so as to provide a waterproof, full strength (same as original material) joint through the splice.

Samples (12 inch x 12 inch {300 mm x 300 mm} minimum) of the material along with the material data sheet of the producer of the material shall be submitted to the Central Laboratory for approval.

832.07 Blank.

SECTION 833
LUMBER AND TIMBER - UNTREATED AND TREATED

833.01 Structural Lumber and Timber.

Structural lumber and timber shall be Southern Yellow Pine, unless otherwise noted on the plans or in the proposal, meeting the requirements of AASHTO M 168 "Standard Specification for Wood Products". The grade of structural wood shall be as shown on the plans.

833.02 Preservative Treatment.

Preservatives for treated wood shall meet the requirements of AASHTO M 133 "Preservatives and Pressure Treatment Processes for Timber".

SECTION 834
PILING MATERIALS

834.01 Concrete Piles.

Precast prestressed concrete piles shall be manufactured in accordance with the requirements given in Section 513.

834.02 Steel Pile Point Protectors.

The pile points shall be fabricated from cast steel meeting or exceeding the requirements of AASHTO M 103M. The pile points shall be properly identified as to the heat from which they were fabricated, either by this number being cast into the point or by being legibly stenciled on each point. Certified mill test reports shall be submitted for the pile points in accordance with the requirements given for the submittal of certified mill test reports for Structural Steel.

834.03 Steel Bearing Piles.

The material in rolled steel piles and splices shall conform to the requirements of AASHTO M 270 {AASHTO M 270M}, unless otherwise specified by plan details. All piles shall be rolled steel sections of the section number, size, and weight per foot {mass per meter} indicated on the plans and shall be fabricated in conformity with the requirements of ASTM A 6 {ASTM A 6M}.

The heat number and section size shall be legibly marked on each piece by stamp, paint, tag, sticker or other industry accepted method. Any piece that cannot be properly identified at time of use will be rejected.

834.04 Steel Sheet Piles.

Permanent steel sheet piling shall be of the type called for on the plans and shall conform to the requirements of AASHTO M 202 {AASHTO M 202M} and its supplementary requirement, S1.

Temporary steel sheet piling shall conform to the requirements of AASHTO M 202 {AASHTO M 202M} and its supplementary requirement, S1 and may be either new piling or used piling, acceptable to the Engineer for the intended function. The temporary steel sheet piling shall be interlocking type piles having a 3/8 inch {9.4 mm} minimum web thickness.

834.05 Storing and Handling Steel Piles.

When placed in the leads, the pile shall conform to camber and sweep permitted by allowable mill tolerance. The method of storing and handling shall be such as to avoid undue bending stresses or other injury. Piles bent, cracked, or otherwise injured will be rejected.

SECTION 835
STEEL REINFORCEMENT

835.01 General.

All reinforcing steel shall be Grade 60 {Grade 420} steel, unless otherwise stipulated in these Specifications or specifically designated by plan details. All steel reinforcement bars (smooth and deformed) must come from an ALDOT approved steel mill. Approved steel mills are listed in the Department's Materials, Sources and Devices with Special Acceptance Requirements Manual, List I-12, Deformed and Plain Steel Bar Producing Mills.

All reinforcing bars over 1/4 of an inch {6 mm} in diameter shall have deformations as prescribed in AASHTO M 31.

835.02 Reinforcing Bars.

Steel reinforcement bars 1/4 of an inch {6 mm} or less in diameter shall meet the requirements of AASHTO M 32.

Steel reinforcement bars over 1/4 of an inch {6 mm} in diameter shall meet the requirements of AASHTO M 31.

835.03 Reinforcing Mesh or Mats.

WIRE FOR MESH REINFORCEMENT. - Plain wire for mesh reinforcement shall meet the requirements of AASHTO M 32 . Deformed wire for mesh reinforcement shall meet the requirements of AASHTO M 225 .

WELDED WIRE REINFORCEMENT. - Welded plain wire reinforcement mesh shall meet the requirements of AASHTO M 55 . Welded deformed wire reinforcement mesh shall meet the requirements of AASHTO M 221 .

FABRICATED BAR OR ROD MAT. - Fabricated bar or rod mat shall meet the requirements of AASHTO M 54.

835.04 Spiral Reinforcement.

Spiral reinforcement may be plain or deformed bars or may be cold drawn wire. Plain reinforcing bars shall conform (except for deformations) to AASHTO M 31, Grade 40 {Grade 300} or Grade 60 {Grade 420}. Deformed bars shall conform to Article 835.02. Cold drawn wire shall conform to AASHTO M 32.

835.05 Dowel and Tie Bars for Concrete Pavement.

(a) Dowel Bars.

Dowel bars shall be smooth round bars of the size shown by plan details. The bars shall be fabricated from steel conforming to AASHTO M 31 for Grade 40 or 60 {Grade 300 or 420}, or AASHTO M 227 for Grade 70 {Grade 480} or higher. The bars shall have a corrosion resistant coating conforming to the requirements of AASHTO M 254 for a Type A or Type B coating. One end of each dowel used in an expansion assembly shall be provided with an approved tight fitting non-collapsible expansion cap.

(b) Tie Bars.

Standard tie bars shall be of the size shown by plan details, fabricated from deformed bars meeting the requirements of AASHTO M 31 for Grade 40 or 60 {Grade 300 or 420}.

Sectional tie bars shall be of the size shown by plan details fabricated from deformed bars meeting the requirements of AASHTO M 31 for Grade 60 {Grade 420} steel. Connectors shall be of a type approved by the Engineer.

835.06 Prestressing Steel.

(a) Strand.

Unless otherwise shown by plan details, stressing cables shall meet the requirements of AASHTO M 203 (ASTM A 416) Grade 1860 (270 ksi {1860 MPa}).

(b) Bars.

Stressing bars, when allowed by plan details, shall meet the requirements of AASHTO M 275 (ASTM A 722) for Type 1 or Type II with Mill Test Reports including Supplemental Requirements S1, S2 and S3, unless other requirements are provided by the plans or proposal.

835.07 Use, Care, and Handling.

All reinforcement received on the project shall be placed in approved storage and shall be maintained clean, intact, and free from distortion. Reinforcement shall be free from loose or thick rust, which would impair bond of the steel with the concrete. Rust that produces only discoloration without reducing the cross section of the steel will not be considered objectionable. Only such reinforcement shall be distributed along the construction as needed for immediate use.

SECTION 836
STRUCTURAL STEEL, FASTENERS AND MISCELLANEOUS METALS

836.01 General.

(a) Marking of Steels.

Steels, when received from the mill shall be identified in accordance with ASTM A 6 {A 6M}. On steel piling the heat number and section size shall be legibly marked on each piece by stamp, paint, tag, sticker or other industry accepted method. Any piece that cannot be properly identified at time of use will be rejected until such time documentation or approved testing of the items in question can prove conformance to the requirements.

Certified mill test reports or certified reports of tests made by other agencies which are recognized by the ALDOT, shall be furnished for each heat of steel verifying that the material meets the requirements of the type and grade specified. The Department reserves the right to make its own test of any material, and the material may be rejected if these tests prove the material does not meet the requirements.

For identification purposes, the fabricator shall utilize low stress stencils to dye stamp the mill heat numbers of the flanges and webs in the webs of welded members and in the webs of rolled members. The heat numbers shall be legible, located adjacent to piece marks, and placed centered between the top and bottom flange in the first panel to the left end and near side of the member.

All steel which is required to have a yield point greater than 36,000 psi {250 MPa} shall, at all times in the fabricator's plant, be color marked to identify its AASHTO, ASTM, or special specification.

(b) General Requirements.

1. Structural steel shall conform to the requirements of AASHTO M 270 Grade 36 {Grade 250} unless otherwise noted hereinafter in this Section or shown on the plans.

   AASHTO material specifications shall govern in lieu of ASTM material specifications where an AASHTO equivalent specification exists for all references within any referenced specification.

   With the approval of the Engineer, materials (other than web and flange material and web splice and flange splice material) for members may be taken from stock, provided the fabricator provides all documentation which shows the material conforms to the required specifications, prior to use of such material.

   The term “main member”, as used hereinafter in this section or shown on the contract plans, is defined as any member requiring Charpy V-notch (CVN) testing.

   Structural steel members requiring Charpy V-notch testing shall include, but not be limited to, the following:

   - All rolled beams in the superstructure and steel pier caps.
   - All flanges and webs of steel plate girders and steel pier caps.
   - All cover plates for beams and girders.
   - All flange and web splice plates for beams, girders, and floorbeams or stringer beams.
   - All connection plates welded to rolled beams, steel plate girders, and steel pier caps.
   - All diaphragms or cross frames for curved beams and girders, including their gusset and connection plates.
   - All stringer beams (floorbeams) and any connection plates welded thereto.

- All floorbeam trusses (cross frames) which support stringer beams (floorbeams), including their gusset and connection plates.

The material supplied shall meet the longitudinal Charpy V-notch test noted below. Sampling and testing shall be in accordance with AASHTO T 243 with the (H) frequency of heat testing used. All members requiring CVN testing shall have heat numbers legibly marked during fabrication.

Steel Grade	Thickness	Test Requirements
M 270 Grade 36	Up to 4"	15 ft. lb. @ 70°F. (Min. Ser. Temp. 0°F. and above)
M 270 Grade 50 & Grade 50W	Up to 4" Mech. Fastened Up to 2" Welded Over 2" to 4" Welded	15 ft. lb. @ 40°F. 15 ft. lb. @ 40°F. 20 ft. lb. @ 40°F. (Min. Ser. Temp. -1°F. to -30°F.)
{250}	{Up to 102 mm}	{20 J @ 21 °C} {Min. Ser. Temp. -18 °C and above}
{345 & 345W}	{Up to 102 mm Mech. Fastened} {Up to 51 mm Welded} {Over 51 mm to 102 mm Welded}	{20 J @ 4 °C} {20 J @ 4 °C} {27 J @ 4 °C} {Min. Ser. Temp. -18 °C to -34°C}
If the yield point of the material exceeds 65 ksi {450 MPa}, the temperature of the CVN value for acceptability shall be reduced by 15 °F {8 °C} for each increment of 10 ksi {70 MPa} above 65 ksi {450 MPa}.		

When designated on the plans, the Contractor (Fabricator) shall furnish one main load carrying member (girder flange) 18 inches {460 mm} overlength per individual ALDOT bridge project, in order to provide an 18 inch {460 mm} sample for Departmental job control testing.

Unless otherwise shown on the plans, steel plates for main members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

2. Fasteners, pins and rollers shall conform to the requirements of Articles 836.32, 836.33 and 836.42.

Threads for all bolts and pins for structural steel construction shall conform to the American National Standard for Unified Screw Threads, ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 1.375 inches {35 mm} or more shall be threaded six threads to the inch {25 mm}.

All bolt heads and nuts shall be hexagonal shaped with dimensions conforming to the requirements for Hexagon Structural Bolts and Heavy Semi-Finished Hexagon Nuts of ANSI Standard B18.2.1 and B18.2.2.

3. All cast and built-up bearings shall be shop assembled, checked for fit, securely packaged and shipped as a unit unless otherwise approved by the Engineer. The method of securing the bearing unit for shipment shall be as shown by the plan details or a method acceptable to the Engineer.

The diameter of pins used in cast and built-up bearing shall be within 1/16 inch {1.6 mm} of the diameter specified by the plans with pin holes not in excess of the pin diameter by more than 1/16 inch {1.6 mm}.

4. Copper bearing structural steel, used for structural steel piling, shall conform to the requirements of Article 836.01, except that it shall contain not less than 0.20 percent of copper. Copper bearing steels for other structural uses shall be as specified.
5. High strength and alloy steel shall be in accordance with the following.
    a. Special alloy steels to meet definite corrosion requirements shall be as specified on the plans.
    b. High strength structural steel for bolted and welded construction shall conform to AASHTO M 270 of the Grade as shown on the contract plans (Grade 50 or Grade 50W). AASHTO M 270 Grade 50 {Grade 345} steel shall be limited to structural shapes in groups 1, 2 and 3 in ASTM A 6 {A 6M} and to plates and bars in thicknesses through 4 inches {102 mm}. Plates and bars over 3/4 inch {19 mm} through 4 inches {102 mm} in thickness shall be "killed-fine grain practice."
6. Corrosion-resistant iron chromium and iron chromium-nickel castings for general application shall conform to the requirements of ASTM A 296 of the grade specified on the plans.
7. Anchor bolt assemblies (anchor bolts, nuts, and washers) shall be in accordance with AASHTO M 314 (maximum tensile strength is waived). Galvanization of the anchor bolt from 3 inches {75

mm} below the top of the concrete to the top of the anchor bolt shall be required. The remaining length of the anchor bolt will not be required to be galvanized.

(c) Full Size Testing of Members.

When full size tests of structural members are required the methods and procedures shall be provided in the plans and specifications.

836.02 Steel Forging.

Carbon steel forgings shall, unless otherwise specified by plan details, conform to the requirements of AASHTO M 102 for Class C material. All forgings shall be annealed prior to being machined to form finished parts. A record of the annealing charges shall be furnished the Engineer by the manufacturer showing the forgings in each charge, the melt or melts from which they were secured, and the treatment they received.

836.03 Blank.

836.04 Steel Castings.

Steel castings shall conform to the requirements of AASHTO M 103, Grade 70-36, unless otherwise specified, and the following:

(a) The dimensions of fillets shall not be less than the thickness of the thinnest adjoining section or member nor less than 1/2 inch {13 mm}.

(b) All steel castings shall be annealed, unless otherwise provided, in accordance with AASHTO M 103 {M 103M}. Certification of annealing process shall be furnished by the manufacturer.

(c) Steel castings shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. No finished casting shall have visible blow holes so located that a straight line laid in any direction will cut a total length of cavity greater than 1 inch {25 mm} in any 1 foot {300 mm}, nor shall any single blow hole exceed 1 inch {25 mm} in any dimension or have an area greater than 1/2 square inch {13 mm^2}. Blow holes shall not have a depth injuriously affecting the strength of the casting. Minor defects which do not impair the strength may, if approved, be welded by the electric process. The defects shall be removed to solid metal by chipping, drilling or other satisfactory methods and, after welding, the castings shall be annealed, if required. No cracks, flaws or other defects shall appear after such treatment. No sharp unfilleted angles or corners will be allowed. Castings that have been welded without the Engineer's permission shall be rejected.

(d) All castings shall be blast cleaned of scale and sand so as to present a smooth, clean and uniform surface.

(e) Castings shall be checked for soundness by comparing computed weight {mass} against actual weight {mass} (actual weight {mass} less than 95% of computed weight {mass} shall be cause for rejection of casting) and/or by suspending the casting and hammering it all over, comparing soundness of the ring.

836.05 Gray Iron Castings.

(a) General.

Gray iron castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. They shall be true to pattern in form and dimensions.

Castings will be classified under one of the following grades:

1. Grade "A".

Grade "A" Castings shall conform to the requirements of Class No. 30 A for Gray Iron Castings, AASHTO M 105.

2. Grade "B".

Grade "B" Castings shall conform to the requirements of Class No. 20 A for Gray Iron Castings, AASHTO M 105.

All castings shall be of the Grade "A" classification unless otherwise noted.

(b) Cleaning.

All castings shall be blast cleaned of scale and sand so as to present a smooth, clean and uniform surface.

(c) Weights {Masses}.

Any casting weighing less than 95% of the weight {mass} computed from its dimensions shall be rejected.

836.06 Malleable Iron Castings.

Malleable iron castings shall conform to the requirements of ASTM A 47, Grade No. 35018. Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The dimensions of fillets shall not be less than provided in Article 836.04. The surfaces shall have a workmanlike finish. Malleable castings shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. Cleaning shall be as provided in Subarticle 836.05(b). Soundness shall be checked as provided in Subarticle 836.04(e).

836.07 Ductile Iron Castings.

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 60-40-18. Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The dimensions of fillets shall not be less than provided in Article 836.04. The surfaces shall have a workmanlike finish. Malleable castings shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. Cleaning shall be as provided in Subarticle 836.04(d). Soundness shall be checked as provided in Subarticle 836.04(e).

836.08 Self-Lubricating Bronze Or PTFE Bearing Plates.

(a) Self-Lubricating Bronze Bearing Plates.

These bearing plates shall be an article of standard production by an established manufacturer of such equipment. They shall be provided with trepanned or drilled recesses (not grooves) which shall be filled with a lubricating compound capable of withstanding the atmospheric elements and consisting of graphite and metallic substances with a lubricating binder. Such compound shall be pressed into the recesses by hydraulic presses so as to form dense non-plastic lubricating inserts. The lubricating area shall comprise not less than 25 percent of the total area. The manufacturer shall furnish additional lubrication and just prior to assembling, the entire sliding surfaces of members in contact with plates shall be thoroughly lubricated with the approved lubricant. The bearing plates shall be made of bronze conforming to the requirements for Bronze Castings for Bridges and Turntables, AASHTO M 107, Alloy D, Copper Alloy 905, except that a maximum of 2-1/2 percent lead will be permitted. This will modify minimum on copper to 84.5 percent, minimum on tin to 8.5 percent and maximum on zinc to 3.75 percent.

The coefficient of friction shall not exceed one-tenth.

(b) PTFE Bearing Plates.

The structural steel portion of the bearing plate shall meet the requirements of AASHTO M 270 GRADE 36 {M 270M GRADE 250} unless shown otherwise on the plans.

The material, fabrication and installation requirements for Polytetrafluoroethylene (PTFE) polymer shall be those given in SECTION 837.

The coefficient of friction shall not exceed one-tenth.

836.09 Grounding Materials For Steel Bridges.

Standard stranded copper grounding conductor shall be bare annealed Class B stranded electric conductor.

Extra flexible grounding conductor shall be Class G bare annealed stranded electric conductor.

Grounding rods shall be 5/8 inch x 8 feet {16 mm x 2.5 m}, minimum size, copperclad steel grounding rods as manufactured by A.B. Chance, McGraw-Edison, Joslyn Manufacturing and Supply Company, or approved equal.

Exothermic welding shall be by the Cadwell process or an approved equivalent method. All materials shall conform to the National Electrical Manufacturers' Association (NEMA) or the Underwriter's Laboratories, Inc. standards.

836.10 Lead Plates, Etc.

Lead used for plates, pipes, etc., shall conform to the requirements of ASTM B 29 for common desilverized lead.

836.11 Hardware For Timber Bridges.

Machine bolts, nuts, washers, drift bolts, lag bolts and screws, dowels, nails, spikes, shear rings and plates and other miscellaneous hardware shall be common stock hardware items, either plain or galvanized. Galvanization when specified shall be in accordance with AASHTO M 232.

836.12 and 836.13 Blank.

836.14 Shop and Working Drawings.

The plans furnished the Contractor by the Department are not intended for use as shop or working drawings. Shop drawings and working drawings will be required as specified in Article 105.02.

All applicable ALDOT specifications shall be referenced on the first shop drawing sheet by specification number and title.

Shop drawings shall include camber and sweep diagrams covering steel portions of all structures.

Fabricators shall furnish verification certificates of the actual measurements of the camber placed in each beam, girder or truss.

836.15 Mill Orders and Shipping Statements.

The Contractor shall furnish the Engineer with as many copies of mill orders and shipping statements as may be directed. The weights {masses} of the individual members shall be shown.

836.16 Notice and Facilities For Inspection.

After the Bridge Engineer has received the fabricator notification required by 508.03(b) and as the fabrication begins, copies of the mill test reports and fabricators material information, for materials which require CVN testing, shall be supplied to the Bridge Engineer or his representative prior to completion and acceptance of fabrication.

No materials or members will be accepted by the Bridge Engineer's representative on structural steel until the Department's form BBF-1 (available from the Bridge Engineer) and the supporting mill test reports for the materials have been furnished and approved by the Department. A complete package of this information shall be given to the ALDOT representative at the fabricator's plant, to be followed by a submittal to the ALDOT Materials & Tests' Certification office where official certification and approval is processed. The BBF-1 form shall be signed by a company official and shall be notarized. The acceptance of members as fabricated may be noted by the affixing of the ALDOT Stamp on the member by the Bridge Engineer's representative.

The Contractor/Fabricator shall provide ALDOT with adequate, suitable office facilities and equipment when required for the inspection of materials and workmanship in the fabrication plant. This office shall be conveniently located near the fabricating plant or work site, shall be private and not shared with the fabricator or any other agency, and shall be equipped so that it may be locked. It shall be climate controlled, water tight, and include necessary office furnishings such as a desk/table, chairs, and file cabinet. (Telephone is optional).

Inspectors shall be allowed free access to the necessary parts of the work. Refer to articles 105.09, 105.10, and 105.11 concerning the duties of the Inspector(s) and inspection of work.

Unless otherwise provided, the Contractor shall furnish, without extra compensation, test specimens as provided herein.

Fabrication shops shall have a master tape calibrated by the National Institute of Standards and Technology. All tapes used in fabrication measurements shall be calibrated with the master tape before being used on the project. Any master tape found damaged or with a certification over two years old shall be replaced or recalibrated.

The quality control program for any fabrication work performed will be subject to the review of the Bridge Engineer. A written current copy of the fabricator's Quality Control Manual and current copies of all nondestructive testing and Quality Control Inspection personnel certifications associated with fabrication work shall be on file with the Bridge Engineer prior to the beginning of work.

Any bridge fabrication facility that is required to have an AISC Certification of Intermediate Bridge or Advanced Bridge shall have a Certified Welding Inspector (CWI) employed by, or retained by, and preferably working with the fabricator's quality control office. A CWI shall be present on all shifts and shall be available at any location that fabrication and welding are to take place.

Quality Control guidelines and all welding code requirements shall conform to the AASHTO/AWS D1.5M/d1.5:2015, Bridge Welding Code, Seventh Edition. If the Bridge Engineer finds the fabricator's Quality Control Department is not providing sufficient inspection on the work in progress, he may suspend all or any portion of the work in progress (reference is made to Article 105.01 and Subarticle 108.07(a)).

Work may resume only after necessary adjustments to the Quality Control Program are instituted which will assure conformance to the contract requirements.

All nondestructive testing personnel shall meet the requirements set forth in the "ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2011)".

836.17 Handling, Storage and Transporting Of Materials.

The loading, unloading, handling and storing of materials shall be so conducted that the metal will not be injured or damaged. Structural material delivered at the bridge shop receiving yard shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected from corrosion. It shall be kept free from accumulations of dirt, grease or foreign matter.

During and after fabrication, proper lifting equipment with the capacity to handle members carefully at all times so that no member or part thereof will be bent, excessively stressed, deformed or otherwise damaged shall be used. Handling of members shall require the use of suitable clamps, plate hooks or other suitable devices. Chains or chokers will not be allowed without the use of a protective shield between the chain and the member. Members longer than 50 feet {15 m} shall utilize a two or more point pickup method. Members shall be transported in such a manner that they will not be excessively stressed, deformed or otherwise damaged. Unless otherwise authorized for exceptionally deep girders, girders and beams shall be stored and transported in a "workway position" as used in the structure with appropriate shoring and blocking methods suitable to the Engineer. Chain tie downs shall be provided with protection shields. Multiple stacking of beams and girders may only be done in a manner acceptable to the Engineer. Any suspected damage from handling, storage or hauling shall be cause for the Engineer to order verification of design camber and/or repair of the beam or girder.

All structural materials shall be examined by shop personnel and/or quality control, at the earliest possible time for evidence of any defects. If pitting or other defects are plainly visible during early stages of fabrication prior to any required surface preparation (sand or shot blasting), evaluation shall be required. Information regarding actual material thickness, amount of area affected and end use of material being evaluated will be submitted to the Engineer for acceptability. Any required conditioning will be allowed only when in compliance with ASTM A 6 {A 6M}.

The above shall also apply to pitting of fabricated material stored prior to shipment and to material delivered to the bridge site. Attention is called to Subarticle 106.05(b).

Preparation and shipment of fabricated pieces shall conform to the following:

Loose Members.

1. Parts not completely assembled in the shop shall be secured, insofar as practicable, to prevent damage in shipping or handling.
2. Projecting parts likely to be damaged during shipment shall be blocked with wood or otherwise protected.

Packages.

1. Pins, small parts and small packages of bolts, rivets, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels. A list and description of the contained material shall be plainly marked on the outside of each shipped container.
2. Anchor bolts, washers, and other anchorage or grillage materials, shall be shipped in time to suit the requirements of the masonry construction.

Loading diagrams shall be provided to the Bridge Engineer for his review when Structural Steel items are to be shipped by barge or railcar.

836.18 Straightening Material.

Rolled material, before it is marked, laid out, or otherwise worked in the shop must be straight or cambered as shown on the plans. Material with sharp kinks or bends may be rejected. If straightening is necessary it shall be done by methods that will not injure the metal and must be approved by the Engineer. Heat straightening will be permitted provided the metal is not heated above 1100°F {590 °C}. (controlled by the use of heat crayons furnished by the Fabricator or other approved means). After heating, the metal shall not be artificially cooled until after naturally cooling to 600 °F {315 °C} or less. The method of artificial cooling is subject to the approval of the Engineer. Water or water spray misting shall not be used as a means of artificial cooling. After straightening, the surface of the metal shall be carefully inspected for evidence of fracture.

836.19 Workmanship and Finish.

(a) General.

Workmanship and finish shall be first class in every respect. Materials at the shop shall be kept clean and protected from the weather insofar as practical. Shearing, burning, chipping and grinding shall be neatly and accurately done in a workmanlike manner.

Damage incurred to members or the surfaces of members for any reason shall be cause for the Engineer to order the damage repaired or to reject the member in accordance with the following:

1. Except as noted in paragraph 2 below, damage to surfaces of plates that does not reduce the plate thickness below the permissible minimum thickness allowed by ASTM A 6 {A 6 M} or the thickness of structural shapes in excess of 1/32 inch {0.8 mm} for material less than 3/8 inch {9.5 mm} in thickness, 1/16 inch {3.2 mm} for materials 3/8 inch to 2 inches {9.5 mm to 50 mm} inclusive in thickness or 1/8 {3.2 mm} in for material over 2 inches {50 mm} thick are considered repairable. Damage in excess of the limits noted will be evaluated by the Engineer as to whether to reject or allow repair of member.
2. Surface indentation of members caused by lifting devices shall be evaluated by the Bridge Engineer's representative to determine if the damage is repairable and if repairable, the repairs necessary for acceptance. Continued use of lifting devices that cause damage, especially that which reduces the specified thickness by more than 1/16 inch {1.6 mm}, will be cause for the rejection of all such members so damaged.
3. In general, when allowed, repair work will consist of welding and/or grinding of the surfaces; however, when evaluation of base metal defects becomes necessary, such evaluation shall be done in the presence of the Bridge Engineer's representative. The type of evaluation shall be determined by the fabricators quality control personnel subject to the approval of the Bridge Engineer's Representative. After evaluation of such defects and where welding is necessary on rolled surfaces, stringer beads shall be placed parallel to the direction of stress. All welding shall be performed by competent welders using low hydrogen welding electrodes and/or welding consumables listed in an ALDOT approved welding procedure (WPS). The Engineer shall be the sole judge as to the acceptability of the repair work; any unacceptable work shall be cause for rejection of a member.
4. A form of buffer and/or shield shall be utilized during fitting operations to protect base materials from damage caused by fitting tools or devices. If evidence of base metal damage appears due to misuse of such devices, the material may be deemed unacceptable.

(b) Details.

1. Bends and crimps shall conform to wood or metal templates. All bending or crimping shall be done to the bend lines shown on the plans by a mechanically operated press without avoidable or unnecessary decrease in section.

2. All material shall be bent cold when practical. Cold bending of rolled steel plates shall conform to the following:

a. They shall be so taken from the stock plates that the bending line will be at right angles to the direction of rolling.

b. The radii of bends, measured to the concave face of the metal, shall not be less, and preferably shall be greater, than shown in the following table.

Plate Thickness "t"	Bend Radii For All Grades of Steel
$t \leq 1/2$ in {$t \leq 12$ mm}	2t
1/2 in. $< t \leq 1$ in. {12 mm $< t \leq 25$ mm}	2.5t
1 in. $< t \leq 1.5$ in. {25 mm $< t \leq 38$ mm}	3t
1.5 in. $< t \leq 2.5$ in. {38 mm $< t \leq 60$ mm}	3.5t
2.5 in. $< t \leq 4$ in. {60 mm $< t \leq 100$ mm}	4t

If a shorter radius is essential, the plates shall be bent hot. Hot-bent plates shall conform to requirement Item 1 above.

c. Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch {1.6 mm} throughout that portion of the plate at which the bending is to occur.

3. When hot bending is necessary, the metal shall be carefully heated to a temperature not to exceed 1100 °F {590 °C}. as evidenced by heat crayons or other approved means. Material that has been heated shall be slowly cooled after the bending has been completed.

4. Material that is overheated, fractured, or otherwise injured or damaged shall be rejected.

(c) Camber or Curving of Beams and Girders.

Camber in rolled beams shall be accomplished by the heat up-set method utilizing the lowest possible temperature not to exceed 1100 °F {590 °C}, as evidenced by infrared thermometers or heat crayons. The application of heat shall be carefully supervised using a method acceptable to the Engineer.

Camber for built-up girders shall be accomplished by cutting the web to the prescribed camber with suitable allowance for shrinkage due to cutting and welding. However, moderate variation from the prescribed camber tolerance may be corrected by a carefully supervised application of heat not to exceed 1100 °F {590 °C} as evidenced by infrared thermometers or heat crayons.

Horizontal curving of rolled beams shall be accomplished by the heat up-set method which will require a written procedure approved by the Engineer. Said procedure shall utilize the lowest temperature possible but not in excess of 1100 °F {590 °C} as evidenced by infrared thermometers or heat crayons.

Horizontal curving of built-up girders shall be accomplished by cutting flange plates to the radii shown by the plan details from wider plates, unless the heat up-set method is allowed by the plans or proposal. When the heat up-set method is allowed, such will require a written procedure approved by the Engineer. Said procedure shall utilize minimum temperatures not to exceed 1100°F {590 °C} as evidenced by infrared thermometers or heat crayons.

After heating of metals as noted, the metal shall not be artificially cooled until after naturally cooling to 600°F {315 °C}. or less. The method of artificial cooling must be acceptable to the Engineer. Water or water spray misting shall not be used as a means of artificial cooling. Any material that is heated above the temperature limit noted will be rejected until tests and investigations reveal the material is suitable for use. The Fabricator shall be solely responsible for providing any test data or other information deemed necessary by the Engineer to evaluate the acceptability of the material at no cost to the Department.

The fabricator's Quality Control Inspector shall furnish verification certificates of the actual measurements of the camber, overall length and horizontal sweep placed in each beam or girder. Actual measurements shall be verified and recorded by the Fabricator's Quality Control Inspector.

(d) Straightness, Camber, and Sweep in Welded Beams, Girders, and Ancillary Products.

1. Straightness of Welded Beams and Girders (No Required Camber or Sweep).

If requirements for camber and sweep are not given in the contract, welded beams and girders shall be straight within a plus and minus tolerance for straightness. The straightness tolerance shall be +/- 1/8 inches per foot times the number of feet from the nearest end of the beam or girder divided by 10 {+/- 3 mm times the number of millimeters from the nearest end of the beam or girder divided by 3000}.

2. Tolerance for the Camber of Welded Beams, Girders, and Bridge Deck Joint Armor Plates.

The camber of welded beams, girders, and armor plates shall be within a plus and minus tolerance measured in inches. The tolerance shall be + 1/8 inches and - 0 inches per foot times the number of feet from the nearest end of the beam, girder, or armor plate divided by 10 {+ 3 mm and - 0 mm times the number of millimeters from the nearest end of the beam, girder, or armor plate divided by 3000}.

3. Tolerance for the Sweep of Welded Beams and Girders.

The sweep of horizontally welded beams and girders shall be within a plus and minus tolerance measured in inches. The tolerance shall be +/- 1/8 inches per foot times the number of feet from the nearest end of the beam or girder divided by 10 {+/- 3 mm times the number of millimeters from the nearest end of the beam or girder divided by 3000}.

The horizontal alignment of the sweep of the top and bottom flanges at any point along welded beam or girder shall be within 3/8 inch {10 mm).

(e) Surface Profile at the Centerline of Structural Steel Finger Joints.

The profile of the surface of a structural steel finger joint, measured along the centerline of the finger plate sections of the finger joint (transverse to the centerline of the roadway) shall be within a plus and minus tolerance. The tolerance shall be + 1/16 inch and - 0 inches per foot times the number

of feet from the nearest end of the joint divided by 10 {+ 2 mm and - 0 mm times the number of millimeters from the nearest end of the joint divided by 3000}. When all fabrication is completed the flat surfaces of each finger plate section shall be straight edged for flatness and any area found exceeding 1/8 inch in 10 feet {3 mm in 3 m} shall be marked and corrected by approved methods. A 10 foot {3 m} straight-edge shall be used and lapped at least 5 feet {1.5 m} over the prior 10 foot {3 m} check.

836.20 Thermal Cutting.

Steel may be thermal cut, provided a smooth surface is secured by the use of a mechanical guide. Thermal cutting by hand shall be done only when approved, and the surface shall be made smooth by planing, chipping or grinding. Re-entrant cuts shall be filleted to a radius of not less than 3/4 inch {19 mm}.

Defects in cut edges shall not be repaired by welding except with approval of the Engineer for occasional notches or gouges less than 7/16 inch {11 mm} deep for material up to 4 inches {100 mm} thick and less than 5/8 inch {16 mm} for material over 4 inches {100 mm} thick. Such weld repairs shall be made by suitably preparing the defect, welding with low hydrogen electrodes not exceeding 5/32 inch {4 mm} in diameter, observing the applicable requirements of Departmental welding requirements and grinding the completed weld smooth and flush with the adjacent surface to produce a workmanlike finish.

Other methods of cutting steel may be acceptable provided the method will produce cut surfaces within the required tolerances for thermal cut surfaces.

836.21 Substitutions.

Substitutions of sections having different dimensions than those shown on the plans shall be made only when approved in writing.

836.22 Fastener Holes.

(a) General.

1. Required Size of Fastener Holes.

In any one connection, all holes may be oversized or slotted by no more than 1/32 inch {0.8 mm}.

In any one connection, a maximum of 10 % of the holes may be oversized or slotted by no more than 1/16 inch {1.6 mm} larger than the nominal diameter of the fastener.

2. Fastener Holes in Main Members.

Holes for connections in structural steel "main members" ("main members" as defined in Article 836.01) shall be made in accordance with one or more of the following procedures:

- Subdrilling and then reaming or drilling all members to full size holes with the members assembled;
- Drilling full size holes in the assembled members by using a steel template with hardened steel bushings with the holes accurately dimensioned from the centerlines of the connection;
- Drilled using Computer Numerically Controlled (CNC) machinery.

Web and flange splice plates shall be match marked to the splice locations regardless of the method used for drilling the holes.

3. Fastener Holes in Members that are not Main Members.

Holes in members other than "main members" ("main members" as defined in Article 836.01) may be punched with a full size die if the thickness of the member is not greater than:

- The nominal diameter of the fastener and;
- Not greater than 3/4 inch {20 mm} for carbon steel and;
- Not greater than 5/8 inch {16 mm} for high strength steel and;
- Not greater than 1/2 inch {13 mm} for quenched and tempered alloy steel.

The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch {1.6 mm}. Punched holes shall be clean cut and without torn or ragged edges.

4. Control of Drilling and Punching and Quality of Fastener Holes.

Web and flange splice plates shall be match marked to the splice locations regardless of the method used for creating the fastener holes. Members drilled while assembled shall be securely held in the correct position while being drilled. Burrs on the metal surfaces shall be removed. Plug welding of any mis-located or mis-sized holes is not allowed.

(b) Accuracy of Punched Holes.

1. If the Engineer finds that the punched work does not comply with requirements hereinafter provided, it may be required that any or all holes be (1) subpunched (or subdrilled) and either reamed or drilled to full size or (2) drilled full size from the solid. All subpunched holes shall be 3/16 inch {4.8 mm} smaller than the nominal diameter of the fastener.

2. The punched holes shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin 1/8 inch {3 mm} smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same surface or in like proportion for any group of holes. If this requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch {4.8 mm} smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

(c) Shop Assembly.

Bolted trusses, arches, continuous beam spans and plate girders shall be assembled in the shop either in an upright position or on their side. After the members have been adjusted to line and fit with proper camber and rigidly fastened (i.e., drift pinned) together, the holes for field connections shall be reamed or drilled.

Filler plates for bolted beam and girder splices have been based on theoretical dimensions. The thickness of the plates shall be adjusted in the shop to take care of any difference greater than 1/16 inch {1.6 mm} between the theoretical and actual dimensions. Splices in members of the same theoretical size will require filler plates if the actual dimensions vary more than 1/16 inch {1.6 mm}.

After assembling, sub-punched or sub-drilled holes shall be reamed to a diameter 1/16 inch {1.6 mm} larger than the nominal diameter of the fastener. Reaming shall be done after all the pieces to be connected are assembled and firmly fastened together. Reaming of fastener holes shall be done with twist drills or with short taper reamers. Where practicable, reamers shall be directed by mechanical means. Burrs resulting from reaming or drilling shall be removed.

(d) Accuracy of Reamed or Drilled Holes.

Reamed or drilled holes shall be cylindrical and perpendicular to the member and their accuracy shall be the same as provided for punched holes (Subarticle 836.22(b)) except that, after reaming or drilling, 85 percent of the contiguous holes in the same surface, or in like proportion for any group of holes, shall not show an offset greater than 1/32 inch {0.8 mm} between adjacent thickness of metal. There shall be no drifting in the shop or field to enlarge mismatched holes. If any holes must be enlarged to admit the fastener, they shall be reamed.

(e) Edge Distance of Fasteners.

1. The minimum distance from the center of any fastener to a sheared or flame cut edge shall be:

1" Fastener: 1-3/4" {45 mm};
7/8" Fastener: 1-1/2" {38 mm};
3/4" Fastener: 1-1/4" {32 mm};
5/8" Fastener: 1-1/8" {29 mm}.

The minimum distance from the center of any fastener to a rolled or planed edge, except in flanges of beams and channels, shall be:

1" Fastener: 1-1/2" {38 mm};
7/8" Fastener: 1-1/4" {32 mm};
3/4" Fastener: 1-1/8" {29 mm};
5/8" Fastener: 1" {25 mm}.

In the flanges of beams and channels the minimum distance from the center of the fastener to a edge shall be:

1" Fastener: 1-1/4" {32 mm};
7/8" Fastener: 1-1/8" {29 mm};
3/4" Fastener: 1" {25 mm};
5/8" Fastener: 7/8" {22 mm}.

2. When enlarged or slotted holes are used the distance between edges of adjacent holes shall not be less than three times the diameter of the fastener minus the nominal diameter of the hole. The distance to an edge shall not be less than the amount shown in Item 836.22(e)1. minus 1/2 the nominal diameter of the hole.

836.23 Through 836.26 Blank.

836.27 Shop Assembling.

(a) General.

All surfaces of metal that will be in contact when assembled shall be cleaned before assembly but shall not be painted unless otherwise specified by plan details.

No temporary welds for fitting aids or for other purposes will be allowed unless shown on the approved drawings.

All welding (including stiffeners) shall be completed on beams or girders before they are put into laydown and/or assembled.

(b) Assembling.

1. Before the reaming or drilling of any holes in a splice for continuous beam spans, continuous plate girder spans and stringer beams, is done, a "laydown", consisting of at least three contiguous shop sections or all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (lengths between field splices) and not less than 150 feet {46 m} in the case of structures longer than 150 feet {46 m}, shall be required. All individual members (girders and beams) which require horizontal curvature shall be processed in the laydown with the required curvature. Shop assembly may proceed so long as one section of the minimum size "lay down" has been satisfactorily assembled in a preceding "lay down."

All trusses shall be assembled in the shop.

All expansion dams (finger joints) shall be assembled in the shop. Expansion dams shall be shipped assembled, including troughs, unless otherwise shown on the plans.

For structures having curved girders, girders with integral steel caps, extreme skews in combination with severe grade or camber, or other complex characteristics, the plans may direct that the entire structure, including the floor system, be assembled in the shop. The assembly, including camber, alignment, accuracy and fit of joints, shall be approved by the fabricator's Quality Control Inspector before reaming or drilling is commenced.

2. The parts of a member shall be assembled, properly aligned with drift pins, and firmly drawn together with bolts before reaming or shop fastening is commenced. Assembled pieces shall be taken apart for the removal of burrs and shavings produced by reaming or drilling operation. The member shall be free from twists, bends and other deformations.

3. Preparatory to the shop fastening of full-sized punched material, the fastener holes, if necessary, shall be spear-reamed for the admission of the fastener. The reamed or drilled holes shall not be more than 1/16 inch {1.6 mm} larger than the nominal diameter of the fastener.

4. Abutting joints in compression members, where so specified on the drawings, shall be faced and brought to an even bearing. No milling shall be done until members are completely shop assembled, unless otherwise provided on the plans. Where joints are not faced (field splices in continuous steel girder lines), the opening shall not exceed 3/8 inch {9.5 mm}.

5. Field splice plates and filler plates shall be bolted to girders and/or beams, at the locations shown on the approved shop drawings, in the fabrication shop after cleaning (blasting) and coating (painting) of both pieces to be joined.

836.28 Blank.

836.29 Match-Marking.

Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked with low stress stencils using figures and letters at least 3/8 inch {10 mm} high, and a diagram showing such marks shall be shown on approved shop drawings. Reamed parts shall not be interchanged.

836.30 Rivets.

In removing rivets, care shall be taken not to injure the adjacent metal, and, if necessary, they shall be drilled out.

836.31 Blank.

836.32 Bolts, and Bolted Connections.

(a) General.

1. This Article does not pertain to the use of high strength bolts.

2. Unfinished and turned bolts and nuts shall conform to the requirements for Grade "A" bolts of ASTM A 307 unless otherwise specified.

3. The holes shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely-against the metal.

4. The heads and nuts shall be drawn tight against the work with a suitable wrench. Where bolts are to be used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut. All bolts shall have cut threads neatly and accurately finished.

5. Permanent unfinished or turned bolts shall have single self-locking nuts or double nuts, unless otherwise shown on the plans.

(b) Unfinished Bolts.

Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of such length that they will extend entirely through their nuts, but not more than 1/4 inch {6 mm} beyond them.

(c) Turned Bolts.

1. Holes for turned bolts shall be carefully reamed and the bolts turned to a light driving fit with the threads entirely outside of the holes and under the washer, and a washer shall be used. The heads and nuts shall be hexagonal.

2. The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125 {3.2 μm}

3. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the threads.

836.33 High Strength Fasteners.

The components of high strength bolt assemblies shall meet the requirements of the following:

ASTM A 325 {A 325M} - Bolts
ASTM A 563 {A 563M} - Nuts
ASTM F 436 {F 436M} - Washers
ASTM F 959 - Direct Tension Indicators

Unless otherwise noted by plan details, or approved by the Engineer, Type 1 bolts shall be used for standard construction and Type 3 bolts shall be used with weathering steel.

Galvanization, where required shall be in accordance with the provisions of ASTM B 695 Class 50. When an Inorganic Zinc Paint Primer is specified on the contract plans, all bolts shall be galvanized.

The producer, supplier and distributor shall submit the documentation required to certify that the bolt assembly components are in compliance with these specifications.

These requirements shall be modified or supplemented as follows:

(a) Quality Assurance.

Acceptance of bolts, nuts, washers and direct tension indicator washers shall be based on the "Production Lot Method" of identification and quality assurance. A production lot is a group of bolts, nuts, washers or load indicator washers that are the same nominal size, are produced from the same heat of steel and are processed together through all operations to the shipping container. The manufacturer shall identify and maintain the integrity of each production lot from raw-material selection through all processing operations and treatments to final packing and shipment.

(b) Manufacturing.

1. Bolts.

Bolts shall meet the hardness requirements given in ASTM A 325 {A 325M}.

2. Nuts.

Nuts to be galvanized shall be heat treated grade DH.

Plain (ungalvanized) nuts shall be grades C, D or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell hardness 180 HB), or heat treated grades DH or DH3. (The hardness requirements for grades C, D and C3 exceed the current AASHTO/ASTM requirements).

Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be such that the nut will turn freely on the bolt in the coated condition. Galvanized nuts shall meet the mechanical requirements of ASTM A 563 {A 563M} and the rotational-capacity test herein (the overtapping requirements of ASTM A 563 {A 563M} paragraph 7.4 shall be considered maximum values instead of minimum, as currently shown).

3. Marking.

All bolts, nuts and washers shall be marked in accordance with the appropriate AASHTO/ASTM Specifications.

(c) Testing.

1. Bolts.

Proof load tests (ASTM F 606 Method 1) are required. Minimum frequency of tests shall be as specified in ASTM A 325 {A 325M} paragraph 9.5.

Wedge tests on full size bolts (ASTM F 606 paragraph 3.5) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in ASTM A 325 {A 325M} paragraph 9.5.

If galvanized bolts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats or top of bolt head.

2. Nuts.

Proof load tests (ASTM F 606 paragraph 4.2) are required. Minimum frequency of tests shall be as specified in ASTM A 563 {A 563M} paragraph 9.3. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping and lubricating.

If galvanized nuts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

3. Washers.

If galvanized washers are supplied, hardness testing shall be performed after galvanizing. (Coating shall be removed prior to taking hardness measurements).

The thickness of the zinc coating shall be measured.

4. Assemblies.

Rotational-capacity tests are required and shall be performed on all plain and galvanized (after galvanizing) bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Washers are required as part of the test.

The following shall apply:

a. Except as modified herein, the rotational-capacity test shall be performed in accordance with the requirements of ASTM A 325 {A 325M}.
b. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification. A production lot change of either the bolt, nut, or washer shall require the testing of additional assemblies.
c. A rotational-capacity lot number shall be assigned to each combination of lots tested.
d. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.
e. The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device (note - this requirement supersedes the current ASTM A 325 {A 325M} requirement that the test be performed in a steel joint). For short bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator, See Subitem 836.33(c)4.i.
f. The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be:

   240° (2/3 turn) for bolt lengths < 4 diameters
   360° (1 turn) for bolt lengths > 4 diameters and < 8 diameters
   480° (1 1/3 turn) for bolt lengths > 8 diameters

g. The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown below:

Diameter (In.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Req. Installation Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	14	22	32	45	59	64	82	98	118

Diameter {mm}	16	20	22	24	27	30	36
Req. Installation Tension {kN}	94.2	147	182	212	275	337	490
Turn Test Tension {kN}	108.3	169.1	209.3	243.8	316.3	387.6	563.5

h. After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

$$\text{Torque} \leq 0.25\ PD$$

Where: Torque = measured torque (foot-pounds); P = measured bolt tension (pounds) and D = bolt diameter (feet).

i. Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Subitem 836.33(c)4.g. need not apply. The maximum torque requirement of Subitem 836.33(c)4.h. shall be computed using a value of P equal to the turn test tension shown in the table in Subitem 836.33(c)4.g.

5. Reporting.

The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO specifications shall be recorded.

The location where tests are performed and the date of tests shall be recorded.

(d) Documentation.

1. Mill Test Report(s) (MTR).

An MTR shall be furnished for all mill steel used in the manufacture of the bolts, nuts, and washers.

The place where the material was melted and manufactured shall be shown on the MTR.

2. Manufacturer Certified Test Report(s) (MCTR).

The manufacturer of the bolts, nuts and washers shall furnish test reports (MCTR) for the item furnished.

Each MCTR shall show the relevant information required in accordance with Item 836.33(c)5.

The manufacturer performing the rotational-capacity test shall include on the MCTR:

a. The lot number of each of the items tested.
b. The rotational-capacity lot number as required in Subitem 836.33(c)4.c.
c. The results of the tests required in Item 836.33(c)4.
d. The pertinent information required in Item 836.33(c)5.
e. A statement that MCTR for the items are in conformance to this specification and the appropriate AASHTO specifications.
f. The location where the bolt assembly components were manufactured.

3. Distributor Certified Test Report(s) (DCTR).

The DCTR shall include MCTR above for the various bolt assembly components.

The rotational-capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.

The results of the tests required in Item 836.33(c)4. shall be shown on the DCTR.

The pertinent information required in Item 836.33(c)5. shall be shown on the DCTR.

The rotational-capacity lot number as required in Subitem 836.33(c)4.c. shall be shown on the DCTR.

The DCTR shall contain a statement that the MCTR are in conformance to this specification and the appropriate AASHTO specifications.

(e) Shipping.

Bolts, nuts and washers from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational- capacity lot number such that identification will be possible at any stage prior to installation.

836.34 Sheared Edges.

Sheared edges of plates more than 5/8 inch {16 mm} in thickness shall be planed to a depth of 1/4 inch {6 mm}. Plates 5/8 inch {16 mm} and less in thickness shall be ground to remove sharp corners and burrs.

Re-entrants corners shall be filleted to a minimum radius of 3/4 inch {19 mm} before cutting.

836.35 Facing Of Bearing Surfaces.

The top and bottom surfaces of steel slabs and base plates and cap plates of columns and pedestals shall be planed, or else the plates or slabs hot-straightened. Parts of members in contact with them shall be faced and shall have full contact when assembled.

For fit-up of sole plates or bearing seats of beams or girders see Article 836.46. Sole plate and masonry plate corrections may be made by planing or hot-straightening. In planing the surface of expansion bearings, the cut of the tool shall be in the direction of expansion.

Cast pedestals shall be planed on surfaces to be in contact with steel, and the surface to be in contact with masonry rough finished.

The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I unless otherwise specified,

Steel slab in contact with Masonry	ANSI 2000 {50 μm}
Steel slabs	ANSI 2000 {50 μm}
Heavy plates in contact in shoes to be welded	ANSI 1000 {25 μm}
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500 {12.5 μm}
Bridge rollers and rockers	ANSI 250 {6.3 μm}
Pins and pin holes	ANSI 125 {3.2 μm}
Sliding bearings	ANSI 125 {3.2 μm}

Surfaces of bronze bearing plates intended for sliding contact shall be carefully milled and polish finished.

836.36 Blank.

836.37 Blank.

836.38 Finished Members.

These shall be true to line and free from twists, bends, and other defects.

836.39 Blank.

836.40 Blank.

836.41 Stress Relieving.

Members such as bridge shoes or pedestals which are built-up by welding sections of plates together shall be stress relieved in accordance with the requirements given in ANSI/AASHTO/AWS D1.5/D1.5M-2008 for stress relieving unless an alternate method has the written approval of the Bridge Engineer.

836.42 Pins and Rollers.

(a) General.

Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than 9 inches {228 mm}in diameter shall be forged and annealed, pins and rollers 9 inches {228 mm}or less in diameter may be either forged and annealed or cold finished carbon steel shafting. Pins and roller material shall conform to one of the following unless a specific Grade or Class is specified by plan details:

4" { 100 mm} in Diameter or less.....AASHTO M 169*, Grade 1016 to 1030, Inclusive
0" to 20" { 0 mm to 508 mm} in diameter.....AASHTO M 102, Class C, Class D or Class G**
0" to 10" { 0 mm to 254 mm} in diameter.....AASHTO M 102, Class F

* This material shall provide the following minimum values:

Yield - 36,000 psi {250 MPa}
Stress in extreme Fiber - 29,000 psi {200 MPa}
Shear - 14,000 psi {97 {MPa}
Bearing on Pins not subject to rotation 29,000 psi {200 MPa}
Bearing on Pins subject to rotation 14,000 psi {97 MPa}

** Rolled material with the same properties may be substituted for this class.

In pins larger than 9 inches {228 mm} in diameter, a hole not less than 2 inches {50 mm} in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Two pilot nuts and two driving nuts shall be furnished for each size pin, unless otherwise provided by plans or directed.

The diameter of pins and rollers shall not exceed 1/16 inch {1.6 mm} plus or minus from the diameter specified by the plans or ordered by the Engineer.

(b) Boring Pin Holes.

Pin holes shall be bored true to gage, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise shown on the plans. Pins shall be parallel to each other unless otherwise shown on the plans. The final surface shall be obtained by a finishing cut. Boring of holes in built up members shall be done during the final lay down operation.

(c) Pin Clearance.

The diameter of the pin holes except as noted in Item 836.01(b)3 shall not exceed that of the pin by more than 1/50 inch {0.50 mm} for pins 5 inches {127 mm} or less in diameter or 1/32 inch {0.80 mm} for larger pins.

836.43 through 836.45 Blank.

836.46 Welds.

(a) General.

Shop welding shall be performed by Submerged Arc Welding (SAW) in accordance with the specification noted herein. In the event the above method cannot be used, approved manual welding or other approved and qualified automatic or semi-automatic methods may be authorized.

Field Welding shall be performed by manual Shielded Metal Arc Welding (SMAW) using approved electrodes and procedures in accordance with the specifications noted herein.

If a minimum of 3 inches (75 mm} of excess material beyond the theoretical end cuts does not exist, extension bars or run-off tabs shall be used at girder ends to insure sound welds on web to flange welds.

All welding shall be subject to the inspection and approval of the Engineer or his representative. During inspection of the work any workman, including welders and inspection technicians, who, in the opinion of the Engineer, produces inferior work, may under the provision of Article 108.06 be disqualified from performing Departmental work.

All welding shall be in accordance with the AASHTO/AWS D1.5M/D1.5:2015, Bridge Welding Code, Seventh Edition as modified by the following:

Article 3.1. A new sentence shall be added to paragraph 3.1.3 as follows:

"Shop welding, except for minor secondary members and minor repair welding, shall be done under a cover of a permanent structure and/or building capable of protecting the actual welding operation from inclement weather. Any standing water that would be dangerous to the welder or operator or to the integrity of the weld itself shall be cause for the welding to stop until such time as the situation is corrected."

Paragraph 3.2.9. The original A.W.S. subclause was deleted but shall be replaced with the following:

"Paragraph 3.2.9. All corners of thermal cut or sheared edges, including edges of flanges of beams and girders along with splice material and other sharp edges deemed undesirable by the Engineer on structural members designated to be coated shall be slightly rounded. Said rounding shall be accomplished by light grinding to produce a satisfactory surface for painting (approximately 1/16 inch {1.6 mm} radius). The grinding shall be performed in such a manner as to produce a neat workmanship like product without nicks or notches in the metal."

A new paragraph to 3.5.1.9 shall be added as follows:

"Paragraph 3.5.1.9 Gaps shall not exceed 0.040 inches {1.0 mm) between the contact surfaces at the bottom flanges of beams or girders and steel bearing plates. There shall be no gap for at least 75% of this contact area."

New Paragraphs 4.9 and 4.10 shall be added as follows:

"Paragraph 4.9 (SAW – single electrode), 4.10 (SAW – parallel and multiple electrodes). A properly operated heating torch shall run immediately ahead (about 12 inches {300 mm}, and on the same side, in advance of the point of welding) of the submerged arc welding head to remove moisture from the steel in the vicinity of the weld when making web to flange fillet welds of plate girders. Gases producing moisture in welding operations are discouraged unless it can be shown that the resultant temperature of the metal is sufficient to vaporize any moisture that might be present."

Paragraphs 6.7.1, 6.7.1.1, and 6.7.1.2 in regard to Nondestructive Testing (NDT) of Complete Joint Penetration groove welds shall be deleted in their entirety and the following substituted in lieu thereof:

"Paragraph 6.7.1 – Complete Joint Penetration (CJP) groove welds shall be tested by A.W.S. D1.5 Bridge Welding Code requirements in regard to and mandating the use of either radiographic testing (RT) or ultrasonic testing (UT) in accordance with the following:
"6.7.1.1 - Shop Welds.

100% of all CJP butt weld splices in the following: all flanges (tension and compression) of beams and girders, all flanges of floorbeams, all members of floorbeam trusses which support stringer beams, all flanges of steel bent caps; and all chords, diagonals and verticals of trusses.

50% of all vertical CJP butt weld splices in webs of beams, girders, floorbeams, and steel bent caps. This requirement shall consist of 25% of the web depth beginning at the top of the web plate and 25% of the web depth beginning at the bottom of the web plate. If rejectable discontinuities are found in the vertical CJP butt welded splices, the remainder of the weld shall be tested.

15% of each longitudinal CJP butt weld splice in the webs of beams, girders, floorbeams, and steel bent caps, and in truss members. This requirement shall consist of 5% of weld length at each end of each plate and 5% of the weld length at the center of the plate (each plate is defined as that portion of web between vertical splices either welded or bolted).If rejectable discontinuities are found in a partially NDT examined longitudinal joint, additional NDT examinations using the original NDT process of that joint shall be made as required by the Engineer.

100% of all CJP welds used at the ends of longitudinal stiffeners welded to girder webs and the CJP welds used to splice sections of the longitudinal stiffeners together.

100% of all CJP groove welds in T- and corner joints (girder stiffener/connection plate to flange welds) shall be tested by UT.

All welded repairs of RT or UT examined joints shall be re-examined by the original NDT process for quality and acceptability in the area of the repair.

6.7.1.2. - Field Welds.

100% of all butt welds in beams, girders, floorbeams, steel bent caps; and chords, diagonals, and verticals of trusses. All repairs of radiographed joints shall be reradiographed in the repair area."

A New Paragraph 6.7.2.1. shall be added as follows:

"Paragraph 6.7.2.1. Magnetic particle examination of all fillet welds and/or reinforcement welds used in bearing assembly fabrication and a minimum of 10% of all fillet welds in expansion dams is required. If defects are found which require repair they shall be re-examined with magnetic particle testing after the repairs are made. Magnetic particle examination shall follow the procedures and requirements as outlined in AWS Subsection 6.7.

A New Paragraph 6.7.7 shall be added as follows:

"Paragraph 6.7.7 Dye penetrant (PT) examination of all welded and finished plate edges of CJP butt weld splices of girder web plate or girder flange plate weld splices in main members is required. This examination shall be performed in addition to the required radiographic testing (RT) or ultrasonic testing (UT). If defects are found which require repair these areas shall be re-examined with PT after repairs are made. Written documentation of all non-destructive testing performed on all welding which requires NDT testing shall be submitted to the ALDOT representative within 48 hours of completion of the tests.

(b) Qualification of Welders.

Field welders shall be prequalified according to the standard qualification procedure of the applicable AWS Specifications and amendments thereto as noted in Subarticle 836.46(a). A welder that passes the required test procedure without requiring a retest will then be qualified for the next three years with no test required provided his performance is satisfactory. During this three year period a new card will be issued for one-year periods when the welder presents evidence that he has been welding during the previous six month period. Welders that require a retest to become qualified must take and pass the test each year. Field welders must have a current qualification card on his person at all times that he is doing field welding.

(c) Shop Welding.

1. The Contractor or his representative shall furnish to the Department a written report that shall cover the welding procedure specification (WPS) for each process and joint used in shop welding. This report shall be submitted in duplicate on a format approved by the Department.

2. All shop welds shall be properly identified so that it can be determined by the Engineer which welder performed the work.

3. The AWS joint designation shall appear in the tail of the weld symbol on the shop drawing.

4. Each full penetration weld that is to be tested by ultrasonic or radiographic testing shall be assigned a unique number by the preparer of the shop drawing. This number shall serve to identify that particular weld and shall also appear on all nondestructive test reports and x-ray film.

5. Whenever there are members identified on bridge plans or structural shop drawings as fracture critical members, post weld heating shall be used to prevent cracking in the heat affected zone due to hydrogen embrittlement. The cost of post weld heating will be considered a subsidiary obligation of the fabrication process.

(d) Field Welding.

Only authorized welding shall be done in the field. Unauthorized indiscriminate welding shall not be done to attach temporary construction details to beams, girders, or other main members without approval of the Construction Bureau. Welding is strictly prohibited in areas where this restriction is shown on the plans (tension flanges) and other critical areas (fractural critical members) noted in these specifications.

(e) Non Destructive Testing.

All non-destructive testing required by these Specifications shall be performed by the Contractor (Fabricator) at his expense.

836.47 & 836.48 Blank.

836.49 Painting.

Shop coating shall meet applicable requirements of Section 521.

836.50 Protection Of Machine Finished Surfaces.

Machine-finished surfaces in general shall be shop painted except for the following:

Driven pins and pin holes; surfaces in sliding contact; bronze, and steel surfaces opposing bronze in sliding contact; other surfaces as noted on the plans. Machine surfaces of steel not requiring paint should receive a heavy shop coat of Petrolatum meeting the requirements of ASTM D 217, NLGI Grade 2 or 3 or Military Specification C-16173D, Grade 1. Other approved coating may be used. Surfaces opposing bronze in sliding contact, if shipped assembled with bronze, shall be coated and assembled with the lubricant supplied by the bronze manufacturer. If not shipped assembled with bronze, such surfaces shall receive a shop coating, which shall be removed before field assembly. The lubricant furnished by the bronze manufacturer shall then be applied.

No paint or protective coating shall be applied to bronze.

SECTION 837
ELASTOMERIC BEARING MATERIALS

837.01 Description.

Elastomeric bearings shall be classified by Type in accordance with the following:

BEARING TYPE	Plain Elastomer	Layers of Elastomer With Internal Steel Laminate Plates	Bearing Plate Vulcanized to the Elastomer	PTFE Surfacing Bonded to the Bearing Plate on the Elastomer. Stainless Steel Surfacing Attached to a Second Bearing Plate.
Type 1	X			
Type 2		X		
Type 3	X		X	
Type 4		X	X	
Type 5		X	X	X

837.02 Required Physical Properties.

(a) General.

The materials for the elastomeric bearings shall meet the requirements given in AASHTO M 251, Appendix X1.

Physical property tests shall be performed in accordance with applicable AASHTO, ASTM, and ALDOT procedures.

(b) Elastomer.

The elastomer, unless otherwise specified, shall be 100% virgin polychloroprene (neoprene). Natural rubber, vulcanized rubber (natural or synthetic) or other synthetic rubber-like materials will not be accepted.

The elastomer for Type 1 and Type 3 bearings (bearings without internal laminate plates) shall be 60 Durometer hardness.

The elastomer for Type 2, Type 4, and Type 5 bearings (bearings with internal laminate plates) shall be 50 Durometer hardness.

Where bearing plates are required, the elastomeric portion of the pad shall be hot bonded to the bearing plate during the vulcanization of the pad. This process shall form a bond such that removal of the elastomeric portion of the pad from the bearing plate will result in elastomer failure before bond failure.

(c) Internal Steel Laminate Plates for Type 2, 4 and 5 Bearings.

Internal steel laminate plates, unless shown otherwise on the plans, shall have a nominal thickness of not less than 12 gage.

(d) Steel Bearing Plates for Type 3, 4 and 5 Bearings.

Steel bearing plates shall be hot dipped galvanized coated in accordance with the requirements given in ASTM A 123.

The surfaces of the plates that will be bonded to the elastomer shall be cleaned to SSPC 10 "near white metal finish" after galvanization and immediately prior to bonding. The cleaned bonding surface shall be protected from rust that will be detrimental to the strength of the bond.

A portion of the galvanization shall be removed from the bearing plates to allow the field welding for the installation of the bearings. For each weld, a 1 inch {25 mm} wide strip of galvanization shall be removed. This strip of bare metal shall extend across the entire width of the bearing plate.

(e) PTFE for Type 5 Bearings.

The PTFE shall be composed of 100 percent virgin (unfilled) polytetraflouroethylene polymer. The PTFE resin shall be 100 percent pure new material and shall comply with ASTM D 4894. No reclaimed material shall be used.

The PTFE shall meet the following requirements:

PHYSICAL PROPERTIES OF PTFE		
PHYSICAL PROPERTY	ASTM TEST METHOD	SHEET (UNFILLED)
Specific Gravity	D 792	2.16 ± 0.03
Melting Point ºF {ºC}	D 4894	623 ± 2 {328±1}
Tensile Strength psi {MPa}	D 4894	2800 {19.3}
Elongation at Break (%)	D 4894	200

The thickness of the PTFE shall be at least 1/16 inch {1.58 mm} after compression.

The PTFE shall be attached to the bearing plate by adhesive bonding using an adhesive that is approved by the Engineer, in accordance with the instructions of the adhesive's manufacturer. Prior to bonding, the surface shall be etched by an approved manufacturer using the sodium naphthalene or

sodium ammonia process. The peel strength of the bond shall be not less than 20 pounds per inch {3.5 kN/m}, when tested in accordance with ASTM D 429 Method B.

If shown on the plans, the PTFE shall be confined in a recess in the bearing plate for one half of the PTFE thickness. PTFE confined in a recess shall be at least 3/16 inch {4.76 mm} thick when the maximum dimension of the PTFE is less than or equal to 24.0 inches {610 mm}, and 1/4 inch {6.35 mm} when the maximum dimension of the PTFE is greater than 24.0 inches {610 mm}, unless shown otherwise on the plans.

The finished surface of the PTFE shall be smooth, free from bubbles and shall conform to the tolerances shown.

(f) Stainless Steel Surfacing for Type 5 Bearings.

The required thickness of the stainless steel sheet may be shown on the plans. If not shown, the thickness shall be at least 1/16 inch {1.58 mm} when the maximum dimension of the surface is less than or equal to 12.0 inches {305mm} and 1/8 inch {3.18 mm} when the maximum dimension is larger than 12.0 inches {305 mm}.

The stainless steel surfacing shall meet the requirements of ASTM A 240, Type #304 and the requirements of ASTM A 480 and shall have a No. 8 Finish (mirror finish) on the side in contact with the PTFE layer. Unless otherwise shown on the plans, the coefficient of friction between the bearing element (bearing plate with PTFE) and the stainless steel shall not be more than 0.06 at 800 psi {5.5 MPa} compressive loading. The stainless steel component shall be furnished as one piece of steel if it is shown on the plans to be a single piece.

After removal of the galvanization on the bearing plate in the footprint of the stainless steel sheet, each sheet shall be attached to the bearing plate by seal welding around the entire perimeter so as to prevent entry of moisture between the stainless steel sheet and the bearing plate. After welding, the bead and any damaged galvanized area shall be repaired as per the sprayed zinc (metallizing) requirements of ASTM A 780. Welds shall conform to the American Welding Society requirements for stainless steel. After welding, the stainless steel sheet shall be flat, free from wrinkles and in continuous contact with its sole plate.

(g) Manufacturing Requirements.

Types 1, 2, 3, and 4 pads shall be fabricated in accordance with AASHTO M 251. Type 5 pads shall be fabricated in accordance with the manufacturer's recommendations.

(h) Tolerances.

Pads shall be manufactured in accordance with plan details and shop drawings with applied tolerances as established in AASHTO M 251. Type 5 bearing pads shall in addition to AASHTO M 251 meet the following tolerances:

FLAT PTFE SLIDING BEARING TOLERANCES			
ITEM	THICKNESS	DIMENSION	FLATNESS OR OUT-OF-ROUND
PTFE	-0.000" , +0.0063" {-0.00mm, +0.160mm}	-0.000", +0.030" {-0.00mm, +0.76mm}	0.001 X Nominal Thickness
Stainless Steel	-0.000" , +0.0063" {-0.00mm, +0.160mm}	-0.000", +0.125" {-0.00mm, +3.18mm}	0.001 X Nominal Thickness

837.03 Marking, Sampling, and Testing.

Bearings shall be divided into lots and marked in accordance with AASHTO M 251, Appendix X1 as modified in ALDOT-368 to allow pads of the same type but different sizes to be grouped together in a lot. Bearings less than 3 inches {75 mm} in thickness may have markings placed on the top surface in lieu of the side. Lots may contain up to 3 additional pads for sampling purposes.

Sampling, for Departmental verification testing, shall be in accordance with ALDOT 368 and the ALDOT Testing Manual.

In addition to ALDOT testing, manufacturers shall, as a minimum, test all lots to Level 1 of AASHTO M 251, Appendix X1. Manufacturers shall furnish certified test reports showing actual test results for all parameters found in Table X1 of AASHTO M 251. In addition, steel reinforced pads shall have test results covering the peel strength test and certification that all pads have been proof loaded and passed the requirements for Level 1 criteria, as well as a mill test report for the steel laminates showing the actual physical and chemical analysis for the heat of steel.

Mill test reports shall also be submitted for all bearing plates.

The manufacturer shall furnish certification that the Type 5 bearing assembly meets the requirement for the maximum allowable coefficient of friction between the PTFE and the stainless steel sheet.

SECTION 841
STRUCTURAL PLATE FOR PIPE, PIPE-ARCHES AND ARCHES

841.01 Description.

(a) General.

Corrugated metal structural plate pipe, pipe-arches, and arches shall meet requirements noted in this Section and the details shown on the plans.

Acceptance of material will be based on job site inspection for workmanship and compliance with fabrication requirements.

A certificate of compliance for each shipment as per AASHTO requirements will not be required; however, a copy of the manufacturer's analysis of the sheets used in the manufacture of the pipe shall be furnished.

For correlation of specified plate thickness and allowable fill heights, see plan details.

(b) Forming and Punching of Plates for Pipe.

Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per meter of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans.

Plates for forming skewed or sloped ends shall be cut to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs, and shall present a workmanlike finish.

Elongation of structural plate pipe may be accomplished by forming plates so that the finished pipe is elliptical in shape with the vertical diameter approximately five percent greater than the nominal diameter of the pipe.

Plates for a pipe arch shall form a cross section made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than 180 degrees nor less than 155 degrees. The bottom shall be an arc of not more than 50 degrees nor less than 10 degrees. The top shall be joined at each end to the bottom by an arc having a radius between 16 and 32 inches {400 and 800 mm} and of not more than 87½ degrees nor less than 75 degrees.

841.02 Corrugated Steel.

Corrugated steel structural plates, fasteners, etc. shall conform to the requirements of AASHTO M 167, with plates hot-dipped galvanized after fabrication, punching, and cutting.

841.03 Corrugated Aluminum.

Corrugated aluminum structural plates, fasteners, etc. shall conform to the requirements of AASHTO M 219 modified to include the following:

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be on a double row with center to center dimension 1.75 inches {45 mm}. In all structures the longitudinal joint shall be composed of two bolts in the valley and crest of each corrugation. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 9.625 inches {245 mm}. The minimum distance from center of hole to edge of plate shall be not less than 1.75 times the diameter of the bolt.

841.04 Bituminous Coatings and Paved Inverts.

Bituminous coatings shall be in accordance with the provisions of Subarticle 850.02(c); however, field coatings may be applied in accordance with the provisions of AASHTO M 243.

Paved inverts shall be in accordance with the provisions of Subarticle 850.02(c); however, field application may be accomplished using the asphalt mastic noted in AASHTO M 243, applied as noted therein to the depth and width required by Subarticle 850.02(c).

841.05 Handling and Storage.

Handling and storage of plates shall be as specified in Subarticle 850.02(f) for pipe. Any spelter damaged in handling shall be painted with two coats of approved galvanizing repair paint, Section 855, or an approved zinc spelter paint.

SECTION 846
PIPE CULVERT JOINT SEALERS

846.01 Rigid Pipes.

(a) General.

Allowable joint materials will be determined based on the shape of the pipe culvert as given in the table below.

Pipe Culvert Shape	Allowable Joint Materials
Round	Rubber Gasket
Arch, Horizontal Elliptical, and Precast Culverts	Rubber Gasket, Bituminous Plastic Cement, or Preformed Flexible Joint Sealant

Note: The joint sealing material requirements of this specification are provided to insure the installed pipe joints provide a soil tight performance. If a more stringent joint performance requirement is deemed necessary during the design phase, the Engineer may specify other materials or a different combination of materials specified above.

(b) Bituminous Plastic Cement.

Bituminous Plastic Cement meeting the Specifications noted in this Section may be used on joints for Arch and or Horizontal Elliptical Pipe and Precast box culverts.

This Specification covers a bituminous joint sealing compound which may be applied cold for sealing the joints of bell and spigot or tongue and groove storm or culvert pipe. Material furnished shall be composed of a steam-refined petroleum asphalt dissolved in a suitable solvent and stiffened with a mineral filler .

Properties: The Bituminous Plastic Cement shall be a smooth uniform mixture, not thickened or livered, and it shall show no separation which cannot be easily overcome by stirring. The material shall be of such consistency and properties that it can be readily applied with a trowel, putty knife, or caulking compound gun without pulling or drawing. When applied to the joint surfaces, it shall exhibit good adhesive and cohesive properties. The material shall meet the following requirements:

1. When applied in a layer 1/16 to 1/8 inch {1.5 mm to 3 mm} thick on a tinned metal panel and cured at room temperature for 24 hours, the Bituminous Plastic Cement shall set to a tough, plastic coating, free from blisters.		
	Minimum	Maximum
2. Grease Cone Penetration	175	250
3. Unit Weight {Unit Mass}, pounds per gallon {kilograms per liter}	9.75 {1.17}	-
4. Non-Volatile	70	-
5. Ash, by ignition, by weights {masses}	15	45

Tests: Methods of tests shall be in accordance with the following:	
Grease Cone Penetration	AASHTO T 187
Non-Volatile	ASTM D 2939
Ash	ASTM D 128

(c) Preformed Flexible Joint Sealant

Preformed Flexible joint sealant meeting the requirements of this Section may be used on joints for Arch and or Horizontal Elliptical Pipe and Precast box culverts. This material shall meet the latest requirements of ASTM C990 “Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants”. The material shall be installed per the manufacturer’s recommendations.

(d) Rubber Gaskets.

Rubber gaskets shall be used on all round pipe joints. This material shall meet the latest requirements of ASTM C443 "Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets". The material shall be installed per the manufacturer's recommendations.

(e) Other Types of Joint Sealers.

External wrap joint sealant meeting the Specifications noted in this Section may be used in addition to and combination with joint material as specified in Subarticle (a) above. This material if or when used shall meet the latest requirements of ASTM C877 "Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections". The material shall be installed per the manufacturer's recommendations.

Other types of joint sealers or gaskets with proven satisfactory performance records may be considered by the Department for use on individual contracts on a trial basis.

846.02 Flexible Pipe Sealers.

(a) General.

Connecting bands complying with the appropriate provisions of the type pipe being used may be considered as a satisfactory sealer provided the installation method provides a water tight joint for the full circumference of the joint, unless otherwise directed. Where a satisfactory joint seal cannot be obtained using only the connecting band, the joint shall be sealed by the use of gaskets designed for this purpose, mastic or other approved material.

The producer of the sealant used in the joints shall furnish the Engineer with a certification showing the physical properties of the material and hydrostatic tests of joints sealed with his material.

(b) Special Joints.

If special joints or sealers are required, such will be designated by plan details.

SECTION 850
ROADWAY PIPE

850.01 Concrete Pipe.

(a) General.

Concrete pipe shall be reinforced circular or reinforced arch concrete pipe.

Circular concrete pipe shall comply with the requirements of AASHTO M 170, except that elliptical steel reinforcement will not be permitted unless such is permitted for special design pipe by details provided in the plans.

Concrete arch pipe shall comply with the requirements of AASHTO M 206.

(b) Special Design.

When so permitted by the plans or in the proposal, pipe of designs other than those shown in the standard plans may be permitted; however, such pipe must meet performance and test requirements specified in AASHTO M 170 and shall be installed under the same specifications as circular pipe.

(c) Classes of Pipe.

Circular pipe and arch pipe shall be of the following classes, corresponding to AASHTO M 170 or AASHTO M 206 classes as tabulated herein.

AASHTO CLASS	ALDOT CLASS	ABBREVIATION
Class II	Class 2 Reinf. Conc. Pipe	Cl. 2 R.C. Pipe
Class III	Class 3 Reinf. Conc. Pipe	Cl. 3 R.C. Pipe
Class IV	Class 4 Reinf. Conc. Pipe	Cl. 4 R.C. Pipe
Class V	Class 5 Reinf. Conc. Pipe	Cl. 5 R.C. Pipe
Class II	Class 2 Reinf. Conc. Arch Pipe	Cl. 2 R.C. Arch Pipe
Class III	Class 3 Reinf. Conc. Arch Pipe	Cl. 3 R.C. Arch Pipe
Class IV	Class 4 Reinf. Conc. Arch Pipe	Cl. 4 R.C. Arch Pipe

(d) Materials.

Coarse aggregate, fine aggregate, cement, steel reinforcement, and water shall meet the requirements of AASHTO M 170 or M 206, whichever is applicable, except as modified in applicable Sections of Division 800, Materials.

(e) Acceptance.

All precast products furnished shall meet the requirements of Section 831.

(f) Handling and Storage.

Pipe shall be handled, transported, delivered, and stored in a manner that will not injure or damage the pipe. Pipe shall not be shipped before it has been inspected and approved. Pipe that is damaged during shipment or handling will be rejected even though satisfactory before shipment. Pipe dropped from platforms or vehicles or in the pipe trench will be rejected.

850.02 Corrugated Steel Pipe.

(a) General.

Corrugated steel pipe used in the construction of roadway culverts shall be either circular or arch pipe meeting the requirements of AASHTO M 36, for Type I, IR, or II culverts, the requirements noted in this Section, and the details shown in the plans.

The pitch and depth of corrugations allowed by the AASHTO Specifications but not covered by plan details must be approved by the Department before use.

Acceptance of pipe will be based on job site inspection for workmanship and compliance with fabrication requirements.

A certificate of compliance for each shipment as per AASHTO M 36 will not be required; however, a copy of the manufacturer's analysis of the sheets used in the manufacture of the pipe will be furnished.

Corrugated steel roadway pipe shall have a protective coating and in most cases requires a paved invert. Certain secondary roads may use plain galvanized steel pipe.

A paved invert will not be required in a Type IR pipe unless needed for abrasion resistance. When such is the case, the requirement for a paved invert in a Type IR pipe will be shown on the plans.

(b) Fabrication.

All pipes furnished under this Section shall be fabricated with circumferential corrugations and a riveted lap joint, or with helical corrugations and a continuous lock seam or welded seam, or helical ribs projecting outwardly with a continuous lock seam extending from end to end of each length of pipe.

In addition, helical corrugated or helical ribbed pipe shall comply with the following:

1. Lock joints or seams shall produce a continuous water-tight seam parallel to the corrugations or ribs and as near as practical to the neutral axis of the corrugations or mid-point between ribs, for all sizes without perforations. The seam shall be so designed and fabricated as to develop strength and serviceability equal to that of riveted pipe of the same wall thickness.

2. Welded seams shall produce a continuous water-tight seam parallel to the corrugations and as near as practical to the neutral axis of the corrugations. The welding process shall be so controlled that the combined width of the weld and the adjacent spelter coat burned by the welding operation shall not exceed three times the thickness of the metal being joined. If the spelter is damaged outside the above specified width, the weld and the damaged area adjacent to the weld shall be cleaned and treated as required by the appropriate Article of AASHTO M 36. A coating of rust on the base metal portions of the weld is not considered a defect. The welding process shall be such that the welded seam strength shall not be less than 70 percent of the base metal.

   The manufacturer of welded seam pipe shall submit a certified test report of his production testing that shows the production will meet the above noted weld strength requirements. One test will be reported for each day's production run with the test performed on the final joint produced for that day.

3. All ends of helical corrugated or helical ribbed pipe which are to be joined to other pipe with coupling bands shall be reformed to provide a minimum of two standard size circumferential corrugations.

(c) Protective Coatings, Linings, and Paved Inverts.

1. General.

Protective coating for corrugated metal round and arch pipe shall meet one of the requirements noted in this Article.

Concrete linings for corrugated steel round pipe shall meet the requirements specified in Subarticle (d) of this Article.

Paved inverts shall be formed by the addition of a smooth pavement in the invert of the pipe filling the corrugations for at least 25% of the circumference for a round pipe and 40% for an arch pipe. The pavement shall have a minimum thickness of 1/8 of an inch {3 mm} above the crest of the corrugations, except where the upper edges intersect the corrugations.

In addition the following will be required for the manufacturer of each length of coated pipe shipped to a project:

a. Each length of protective coated corrugated metal pipe shall have one section covered with duct tape for identification. This covered section shall include the heat number and metal thickness.

b. The section of pipe covered with duct tape shall be marked for easy location by project personnel.

c. Pipe that is not properly taped shall not be placed on a project until it has been sampled and tested by the Central Laboratory.

2. Coating.

Bituminous coating shall meet the requirements of AASHTO M 190 for Type "A" Pipe.

Polymeric coatings on precoated metal sheets meeting the requirements of AASHTO M 246 for Type "B" sheets may be used provided the pipe is fabricated so that the heavier coating is located on the inside of the pipe.

3. Paved Inverts.

Paved inverts for bituminous coated pipe shall conform to the requirements of AASHTO M 190 for Type "C" Pipe.

Paved inverts for pipe formed from precoated metal sheets shall be compatible with the coating material, capable of providing an acceptable bond with coating material and otherwise meeting the same basic test requirements of Section 5 of AASHTO M 190.

4. Concrete Lining.

Concrete lined pipe shall be bituminous coated on the outside as outlined in Item 2 above. Although not required, bituminous coating of the inside of the pipe will be permitted.

Concrete for the lining shall be composed of cement, fine aggregate, and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregated lining. The cement shall be Portland cement, Type II, conforming to AASHTO M 85. Aggregate shall conform to the requirements of AASHTO M 6 except the sections on gradation and uniformity of gradation. 100% of the aggregate shall pass the No. 4 {4.75 mm} sieve with not more than 10% passing the No. 200 {75 µm} sieve. The concrete used as lining shall have a minimum 28 day compressive strength of 5000 psi {35 MPa} when tested in accordance with AASHTO T 22.

The concrete lining shall be applied in one or more courses by a machine traveling through the pipe and discharging the concrete over stationary pipe sections. The rate of travel of the machine and the rate of concrete discharge shall be regulated so as to produce a homogeneous, non-segregated lining throughout.

The lining machine shall be equipped with attachments for mechanically troweling the concrete lining. The trowel attachment shall be such that the pressure applied to the lining will be uniform and shall produce a lining that has a uniform thickness and a smooth surface. The concrete lining thickness shall be 3/8 inch $\pm$ 1/8 inch {10 mm $\pm$ 3 mm} over the inside crests of the corrugations.

The manufacturer shall submit certifications stating the gage of the pipe and that the cement, aggregate, and the lining itself all comply with the above specifications. Random samples of the cement, aggregate, and cylinders made from the lining mixture shall be submitted on request of the Department. If cylinders are required, they shall be made from the last batch mix of the day's operation. Either standard rodded cylinders or cylinders compacted and cured in the same manner as the pipe lining will be acceptable. The minimum average 28 day compressive strength of cylinders tested from any one batch shall be 5000 psi {35 MPa}.

(d) Connecting Bands.

Connecting bands shall be made of material conforming to AASHTO M 218 or to AASHTO M 274 depending on the type of metallic coat on the pipe. All bands shall have a minimum of two circumferential corrugations which shall effectively engage the second, as a minimum, circumferential corrugated valley from the end of each pipe. Connecting bands shall be no more than three nominal sheet thicknesses lighter than the thickness of the pipe to be connected but in no case lighter than 17 gage.

Bolts and nuts for connecting bands, furnished in sufficient sizes and numbers to adequately perform the intended function, shall conform to the requirements of ASTM A 307. Band connection hardware consisting of bolts, nuts, bars, and rivets shall be galvanized in accordance with the requirements of AASHTO M 232 or be coated by the electroplating process as provided in ASTM B 633 Class Fe/Zn 8.

Protective coatings for connecting bands shall be the same as used on the pipes which are being connected and shall meet the appropriate requirements for such noted in Subarticle (c) above.

(e) Blank.

(f) Handling and Storage.

Pipe shall be handled, transported, delivered, and stored by methods that will not damage the pipe or bituminous coating, and with the paved invert at the bottom of the pipe. Any pipe damaged or bent will be rejected even though previously inspected and found satisfactory, and shall be replaced or repaired at the Engineer's option, without additional compensation. Damaged coating or paving shall be repaired in a manner satisfactory to the Engineer using approved materials.

850.03 Corrugated Aluminum Pipe.

(a) General.

Corrugated aluminum pipes used in the construction of roadway culverts shall be either circular or arch pipe meeting the requirements of AASHTO M 196 except as provided in this Article or shown on the plans.

The pitch and depth of corrugation allowed by the AASHTO Specifications but not covered by plan details must be approved by the Department before use.

Acceptance of pipe will be based on job site inspection for workmanship and compliance with fabrication requirements.

A certificate of compliance for each shipment as per AASHTO M 196 will not be required; however, a copy of the manufacturer's analysis of the sheets used in the manufacture of the pipe shall be furnished.

For correlation of the specified plate thickness of corrugated metal pipe, and aluminum sheet thickness shown in the detailed plans, the following shall apply:

Aluminum Sheet Thickness (Nominal) Table 3 AASHTO M 197	Specified Culvert Sheet Thickness (Nominal) Table 4 AASHTO M 218
0.060 inches {1.5 mm}	0.064 inches {1.6 mm}
0.075 inches {1.9 mm}	0.079 inches {2.0 mm}
0.105 inches {2.7 mm}	0.109 inches {2.8 mm}
0.135 inches {3.4 mm}	0.138 inches {3.5 mm}
0.164 inches {4.2 mm}	0.168 inches {4.3 mm}
NOTE: Minimum acceptable aluminum sheet thickness 0.060 inches {1.5 mm}. Tolerances for aluminum sheet thickness noted in Table 1 AASHTO M 197 shall apply.	

(b) Fabrication.

All pipe furnished under this Article shall be fabricated with circumferential corrugations and a riveted lap joint or with helical corrugations and a continuous lock seam or welded seam extending from end to end of each length of pipe provided the seams and ends of the pipe comply with the additional requirements of paragraph 2 of Subarticle 850.02(b).

(c) Bituminous Coating and Paved Invert.

Bituminous coatings and paved inverts shall comply with the requirements of Subarticle 850.02(c).

(d) Connecting Bands.

The width and design of connection bands shall be as noted in AASHTO M 196 with the pitch and depth of corrugations, etc. consistent with the type corrugations of the pipe being used. Bituminous

coating for use with bituminous coated pipe and pipe arches shall conform to the appropriate requirements of AASHTO M 190.

(e) Handling and Storage.

Handling and storage shall meet the requirements of Subarticle 850.02(f).

SECTION 851
SIDE DRAIN PIPE

851.01 Concrete Pipe.

(a) General.

Concrete pipe shall be reinforced circular or reinforced arch concrete pipe except that pipe 24 inches {600 mm} or less in diameter, and equivalent size arch pipe, may be plain concrete provided the pipe meets all other requirements of this Article.

(b) Special Design.

When so permitted by the plans or in the proposal, pipe of designs other than those shown in the standard plans may be permitted; however, such pipe must meet the performance and test requirements specified, for AASHTO M 170 and shall be installed under the same specifications as circular pipe.

(c) Classes of Pipe.

1. Plain Concrete Pipe (PC).

Only plain concrete pipe 24 inches {600 mm} or less in diameter (or equivalent area in arch pipe) will be permitted. Circular pipe shall meet the requirements for Class 2 pipe of AASHTO M 86 or for Class II of AASHTO M 170 without steel reinforcement, provided the same strength requirements for the same size pipe provided in AASHTO M 86 for Class II pipe are met. Arch pipe equivalent to a 24 inches {600 mm} diameter round pipe or less shall meet the requirements for Class A-II of AASHTO M206 without steel reinforcement provided the same strength requirements of the equivalent size circular pipe provided in AASHTO M86 for Class 2 pipe are met.

2. Reinforced Concrete Pipe (RC).

Circular pipe shall meet the requirements of AASHTO M 170 for the class of pipe designated by the plans.

Arch pipe shall meet the requirements of AASHTO M 206 for the class of pipe designated by the plans.

(d) Materials.

Coarse aggregate, fine aggregate, cement, steel reinforcement, and water shall meet the requirements of AASHTO M 170 or M 206, whichever is applicable except as modified in applicable Sections of Division 800, Materials.

(e) Tests.

All precast products furnished must meet the requirements of Section 831, Precast Concrete Products.

(f) Handling and Storage.

Handling and storage shall meet the requirements of Subarticle 850.01(f).

851.02 Corrugated Steel Pipe (CS).

CS used in the construction of side drain culverts shall be either circular or arch pipe meeting the requirements of Article 850.02, except that most side drain pipe may use plain galvanized steel pipe.

851.03 Corrugated Aluminum Pipe (CA).

CA used in the construction of side drain culverts shall be either circular or arch pipe meeting the requirements of Article 850.03.

851.04 Vitrified Clay Pipe (VC).

(a) General.

VC used in the construction of side drain culverts shall meet the requirements of AASHTO M 65 or ASTM C 700 for Extra Strength pipe.

(b) Handling and Storage.

Handling and Storage shall meet the requirements of Subarticle 850.01(f).

851.05 Polyvinyl Chloride Pipe (PVC).

PVC shall meet one of the following specifications: ASTM D 2241, F 789, D 1785, D 2665, D 3034, D 2680, F 794, F 949, or F 679.

851.06 Acrylonitrile Butadiene Styrene Pipe (ABS).

ABS shall meet the requirements of ASTM D 2751 or D 2680.

851.07 High Density Polyethylene Pipe (HDPE).

HDPE shall meet the requirements of AASHTO M 294, Type S. HDPE shall be furnished from an approved producer. Approved producers are shown on List I-11, "Producers of High Density Polyethylene Pipe" in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

851.08 High Performance Polypropylene Pipe (PP).

PP shall meet the requirements of AASHTO M 330. PP shall be furnished from an approved producer. Approved producers are shown on List I-14, "Producers of High Performance Polypropylene Pipe" in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

851.09 Special Requirements.

The Specifications for all pipes, as covered by Articles 851.05, 851.06, 851.07, and 851.08 are amended to the effect that any of these materials are acceptable in any configuration which will meet the criteria listed below:

1. Pipe shall have a minimum pipe stiffness as shown in AASHTO M 294 for HDPE, AASHTO M 304 for PVC, ASTM D 2751 for ABS, and AASHTO M 330 for PP when tested in accordance with ASTM D 2412.
2. Fill heights will be restricted to 50 feet {15 m} maximum. Pipe cover shall be 12 inches {300 mm} minimum.
3. All joints shall be soil-tight.
4. Pipe ends shall be encased in accordance with Special Drawing Number HW-614-SP.

SECTION 852
UNDERDRAIN PIPE MATERIALS

852.01 Vitrified Clay Pipe.

This pipe shall meet requirements for standard strength, either plain or perforated pipe of AASHTO M 65 or ASTM C 700.

852.02 Concrete Pipe.

This pipe shall meet the requirements of AASHTO M 86, Class 1 for plain pipe; for perforated pipe AASHTO M 86, Class 1 and AASHTO M 175, Type 1 or 2; for porous concrete pipe, AASHTO M 176, extra strength class, with special attention directed to Section 831, Precast Concrete Products.

852.03 Corrugated Iron or Steel Pipe.

This pipe shall meet the requirements of AASHTO M 36 for Type III, Class I, II, or III Pipe, fabricated from a specified sheet thickness of 0.064 inches {1.6 mm} and may be perforated or non-perforated as required.

852.04 Coated Corrugated Iron or Steel Pipe.

This pipe shall meet the requirements of Article 852.03 coated as specified in Subarticle 850.02(c).

852.05 Corrugated Aluminum Pipe.

This pipe shall meet requirements of AASHTO M 196 for Type III, Class I, II, or III, pipe fabricated from a specified sheet thickness of 0.060 inches {1.5 mm} and may be perforated or non-perforated as required.

852.06 Coated Corrugated Aluminum Pipe.

This pipe shall meet requirements of Article 852.05 coated as specified in Subarticle 850.02(c).

852.07 Poly(Vinyl Chloride) (P.V.C.) Pipe.

This pipe shall meet the requirements of ASTM D 3034. Pipe having a nominal diameter of 4 inches {100 mm} shall have a standard dimension ratio (SDR) of 35; pipe having a nominal diameter of 6 inches {150 mm} or more shall have a standard dimension ratio of either 35 or 41. Perforations, if required, shall be in accordance with the perforation requirements of AASHTO M 175 for either Type 1 or Type 2.

Pipe meeting the requirements of ASTM F 949 or ASTM F 758, Type PS 28 or Type PS 46, may be used in lieu of the above designated pipe.

852.08 Acrylonitrile-Butadiene-Styrene (A.B.S.) Pipe.

This pipe shall meet the requirements of ASTM D 2751 for SDR 42 or SDR 35 pipe. Perforations, if required, shall be in accordance with the perforation requirements of AASHTO M 175 for either Type 1 or Type 2.

852.09 High Density Polyethylene (HDPE) Pipe.

This pipe shall meet the requirements of AASHTO M 252, and in addition have a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Corrugations may be either annular or helical. Pipe may be perforated or non-perforated as required. HDPE pipe shall be furnished from an approved producer. Approved producers are shown on List I-11, "Producers of High Density Polyethylene Pipe" in the Department's "Material, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

852.10 Filter Material.

(a) Type A - Coarse Filter Material.

The coarse filter material may be slag, gravel, or crushed stone, meeting gradation of ALDOT sizes 67, 7, 78, or 710, at the Contractor's option, provided he gives the Engineer written notice of his choice in advance. Soundness and Los Angeles Abrasion tests will not be required.

(b) Type B - Fine Filter Material.

Fine filter material shall be reasonably clean, natural sand or manufactured sand produced from the crushing of quartzite gravel, sandstone, or sandstone conglomerates meeting the following requirements:

Permeability - at least 0.5 mm/sec when measured by the constant head method of AASHTO T 215.

Gradation limits when tested in accordance with AASHTO T 27.	
Sieve No.	% Passing
3/8 inch {9.5 mm}	95 - 100
No. 200 {75 µm}	0 - 7

852.11 Handling and Storage.

Pipe shall be handled, transported, delivered, and stored by methods that will not damage the pipe or coating. Any pipe damaged or bent will be rejected, even though previously inspected and found satisfactory, and shall be replaced or repaired at the Engineer's option, without additional compensation. Bituminous coating scratched or damaged shall be repaired in a satisfactory manner with bituminous material.

SECTION 853
SANITARY SEWER PIPE, MANHOLES, AND APPURTENANCES

853.01 Ductile Iron Sewer Pipe.

Ductile Iron pipe shall meet the requirements of ANSI/AWWA C 151/A21.51 unless otherwise stated in the project specifications and plans. The pipe shall have an inner cement mortar lining meeting AWWA C 104 and an outer bituminous coating. The push-on joints shall meet the requirements of AWWA C 111. The flanged pipe joints shall meet the requirements of AWWA C 115. Restrained joints shall meet the requirements of AWWA C 110. Lock joint pipe shall meet the requirements of AWWA C 151. The pipe length shall be 18 – 20 feet {5.5 – 6.1 meters}.

853.02 Ductile Iron Fittings.

Ductile Iron fittings shall meet the requirements of AWWA C 110 or AWWA C 151 when approved by the Engineer. Fittings shall have an inner cement mortar lining meeting AWWA C 104 and an outer bituminous coating. The fitting shall have a minimum pressure rating equal to the pipe being installed.

853.03 Polyvinyl Chloride Sewer Pipe (PVC) and Fittings.

Pipe for pressure flow applications shall meet the requirements of ASTM D 2241 for SDR 17 or AWWA C 900 for DR 18 with a minimum cell classification 12454-B as defined in ASTM D 1784. Fittings for pressure flow applications shall be ductile iron meeting the requirements of AWWA C 110. Pipe and fittings for gravity flow applications shall meet the requirements of ASTM D 2665, ASTM D 3034 for SDR 35, or ASTM F949 with a minimum cell classification 12454-B as defined in ASTM D 1784. Marking tape shall be provided for all PVC force mains to allow for locating by location equipment.

853.04 High Density Polyethylene Pipe (HDPE) and Fittings.

HDPE pipe and bends shall meet the requirements of ASTM D 1248, ASTM D 3350 (Grade PE 3408), and ASTM F 714. The HDPE pipe shall have a minimum wall thickness determined by the depth of bury and loading on the pipe.

853.05 High Performance Polypropylene Pipe (PP) and Fittings .

PP pipe and bends shall meet the requirements of AASHTO M330. The PP pipe shall have a minimum wall thickness determined by the depth of bury and loading on the pipe. PP pipe shall be furnished from an approved producer. Approved producers are shown on List I-14, "Producers of High Performance Polypropylene Pipe" in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

853.06 Handling and Storage of Pipe.

Pipe shall be handled, transported, delivered, and stored by methods that will not damage the pipe, coatings, or linings. Any pipe damaged or bent will be rejected even though previously inspected and found satisfactory, and shall be replaced or repaired at the Engineer's option, without additional compensation. Coating or linings scratched shall be repaired in a satisfactory manner with appropriate material.

853.07 Joint Materials for Pipe.

Joint material shall provide a suitable waterproof joint capable of withstanding internal pressure of the system involved and be of an approved type. Thermally fused joints will be allowed if installed according to the pipe manufacturer's recommendations.

853.08 Manholes.

Precast reinforced concrete manholes shall meet the requirements of ASTM C 478. The manhole shall consist of the base, riser, transition, and conical sections and shall have a minimal number of joints. The minimum nominal diameter of manholes shall be 48 inches {1220 mm} for pipe sizes less than 24 inches {600 mm}.

The aggregate shall be calcareous rock. Concrete used to cast manholes shall comprised with Type I/II or Type II cement only. The cone shaped top section shall be either conical or eccentric as required by the project plans and specifications. The top section of manholes less than 6 feet {1.82 m} in depth shall be flat concrete slabs and shall conform to the requirements of ASTM C 478. Basis of acceptance

for flat slab tops shall be either proof of design testing or rational design calculations as described in ASTM C 478 and shall be submitted to the Engineer for review. Both cone shaped top sections and flat slab tops shall be designed to withstand a minimum H-20 wheel loading in accordance with AASHTO requirements. A black mastic joint sealer as approved by the Engineer shall be placed on top of the cone section of the manhole before setting the castings to prevent infiltration.

Manholes shall be supplied with pipe cutouts for all incoming and outgoing pipe. The pipe cutouts shall be fitted with flexible manhole pipe connectors (boots) that meet ASTM C 923 and as required by the Engineer.

Cast iron frames and covers shall conform to the Plans in all essentials of design. All castings shall fit the manholes properly. All castings shall be made of clean, even grain, tough gray cast iron. The quality of iron in the castings shall conform to the current ASTM A 48 for Class 30 gray iron castings. Frames and covers shall weigh not less than that shown on the Plans. The castings shall be smooth, true to pattern and free from projections, sand holes or defects and shall properly fit the manhole opening. The portion of the frame and cover which forms the cover seal shall be machined so that no rocking of the cover is possible. The castings shall be coated with coal tar pitch varnish. The cover shall have non-penetrating pick holes. On paved streets, the frame and cover shall be set flush with and in the plane of the paved surface.

Where shown on the plans or directed by the Engineer, sealed castings shall be of the bolted watertight manhole rings and covers and meet the above requirements.

Manhole steps shall be steel rods encased in polypropylene plastic and shall be as approved by the Engineer. Steps may be Type PS-1 or PS-2. Steps shall conform to the requirements of ASTM C 478. Manhole steps shall be driven into the wet wall during manufacture to prevent each from working loose or pulling out.

Manholes shall be constructed in the size, shape, and dimension as detailed in the Utilities Standard Drawings or on the plans.

853.09 Crushed Stone Foundation for Pipe and Manholes.

Crushed Stone shall be screened, washed and 100 percent shall be retained by a 1/4 inch {6 mm} sieve. Crushed stone shall have 100 percent passing a 1 inch {25 mm} sieve and shall be uniformly graded from maximum to minimum size. Foreign matter shall not exceed 3 percent by weight when dry.

853.10 Air and Vacuum Valve.

The air and vacuum valve for sanitary sewer shall permit unrestricted passage of air during filling of the force main and unrestricted entry of air during vacuum of the force main and rated for a minimum of 150 psi {1030 kPa}. The float shall be stainless steel. The valve shall not come into contact with the sewer. The valve shall have a National Pipe Thread (NTP) inlet and shall be fitted with back flushing device. The air and vacuum valve assembly shall be as detailed in the project plans and specifications.

SECTION 854
STORM SEWER PIPE

854.01 Concrete (Storm) Sewer Pipe.

(a) Plain Concrete Pipe (PC).

Only plain concrete pipe 24 inches {610 mm} or less in diameter (or equivalent area in arch pipe) will be permitted. Circular pipe shall meet the requirements for Class 2 pipe of AASHTO M 86 or for Class II of AASHTO M 170 without steel reinforcement, provided the same strength requirements for the same size pipe provided in AASHTO M 86 for Class II pipe are met.

(b) Reinforced Concrete Pipe (RC).

Circular pipe over 24 inches {610 mm} in diameter shall meet the requirements of AASHTO M 170 for Class II unless another class is designated by the plans or proposal.

Arch pipe larger than 18 inch {455 mm} rise by 28.5 inch {725 mm} span shall meet the requirements of AASHTO M 206 for Class A-II unless another class is designated by the plans or proposal.

(c) Acceptance.

In addition to the above requirements, all precast products furnished must meet the requirements of Section 831, Precast Concrete Products.

854.02 Coated, Smooth Lined Corrugated Metal (Storm) Sewer Pipe (CSLCM).

CSLCM shall meet the requirements of AASHTO M 36 or AASHTO M 196 for Type 1A pipe. The shell and liner shall be pre-coated on both sides with a 10 mil {0.25 mm} polymeric coating as per AASHTO M 246.

For correlation purposes the following table provides acceptable shell and liner plate thickness which may be used to equate with Corrugated Metal Pipe (CM) wall thicknesses.

Class of Pipe	Equivalent Single Steel Sheet Wall Thickness	S.L. Wall Thickness	
		Shell	Liner
1	0.064 inches {1.6 mm}	0.052 inches {1.3 mm}	0.04 inches {1.0 mm}
2	0.079 inches {2.0 mm}	0.052 inches {1.3 mm}	0.04 inches {1.0 mm}
3	0.109 inches {2.8 mm}	0.079 inches {2.0 mm}	0.04 inches {1.0 mm}
4	0.138 inches {3.5 mm}	0.109 inches {2.8 mm}	0.04 inches {1.0 mm}
NOTE: For aluminum all thicknesses may be reduced by 0.004 inches {0.10 mm} to compensate for zinc coating.			

Connecting bands shall conform to the appropriate provisions of AASHTO M 36 or M 196 for the type material used and shall have the same type coating as used on the pipe.

Appropriate designed waterproof gaskets shall be used in conjunction with connecting bands to form a watertight joint. Gasket material shall be neoprene or other approved material.

Damage to coatings shall be repaired in accordance with the appropriate provisions of AASHTO M 245 for a polymeric coating.

854.03 Coated Smooth Flow Corrugated Metal (Storm) Sewer Pipe (CSFCM).

CSFCM shall meet the applicable requirements of Article 850.02 or Article 850.03 and the following:

- All pipes shall have a protective coating in accordance with the applicable provisions of Subarticle 850.02(c). In addition the inside of the pipe shall have a paved lining for the entire inside periphery which will fill the valleys to the extent that the thickness above the top of the crest of the corrugations will not be less than 1/8 inch {3 mm}. The lining shall be smooth and uniform and its surface shall be parallel to a line projected along the crest parallel to the centerline.
- Bituminous coating and pavement lining shall conform to the requirements of AASHTO M 246 for Type B sheets with the pavement lining formed from material compatible with the coating material and otherwise meeting the same basic requirements of Section 5 of AASHTO M 190.
- Connecting bands shall meet the requirements of Subarticle 850.02(d) and have appropriate waterproof seals in accordance with Article 846.02.
- Damage to coating and pavement linings shall be repaired in accordance with the appropriate provisions of AASHTO M 245 for polymeric material and approved asphalt mastic as noted in AASHTO M 245.

854.04 Concrete Lined Corrugated Metal (Storm) Sewer Pipe (CL).

CL shall meet the requirements of Article 850.02 or Article 851.02 with the lining as specified in Item 850.02(c)4.

854.05Polyvinyl Chloride (Storm or Sanitary) Sewer Pipe (PVC) and Fittings.

PVC and fittings shall meet the requirements of ASTM D 2665, ASTM D 3034 SDR 35, or ASTM F 949.

854.06 High Density Polyethylene (Storm) Sewer Pipe (HDPE).

HDPE shall meet the requirements of AASHTO M 294, Type S. HDPE shall be furnished from an approved producer. Approved producers are shown on List I-11, "Producers of High Density Polyethylene Pipe" in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

854.07 High Performance Polypropylene (Storm) Sewer Pipe (PP).

PP shall meet the requirements of AASHTO M 330. PP shall be furnished from an approved producer. Approved producers are shown on List I-14, "Producers of Polypropylene Pipe" in the Department's "Materials, Sources and Devices with Special Acceptance Requirements" manual. Information concerning this list is given in Subarticle 106.01(f).

854.08 Handling and Storage.

Pipe shall be handled, transported, delivered, and stored by methods that will not damage the pipe, coatings, or linings. Any pipe damaged or bent will be rejected even though previously inspected and found satisfactory, and shall be replaced or repaired at the Engineer's option, without additional compensation. Coating or linings scratched shall be repaired in a satisfactory manner with appropriate material.

854.09 Joint Materials.

Joint material shall provide a suitable waterproof joint capable of withstanding internal pressure of the system involved and be of an approved type. Joint material for storm sewers shall be the same as specified in Section 530 for Roadway Pipe, or those specified for Sanitary Sewers in Section 645. Thermal fusing will be allowed for PVC pipe joints if installed according to the manufacturer’s recommendations. Other types may be considered if appropriate backup data, etc. is submitted in writing to the Central Office for evaluation.

SECTION 855
COATINGS, PAINTS, ENAMELS, AND VARNISHES FOR METAL AND WOOD STRUCTURES

855.01 General Information.

This Section covers the specifications of the above mentioned materials and their components. Unless otherwise specified, all materials shall be delivered to the job completely mixed and ready for use without the addition of oils or thinners. All materials shall be well ground, shall not settle or cake badly in the container, and shall be readily broken up to a smooth, uniform material. When brushed or sprayed on a smooth, vertical surface, the material shall dry hard and elastic without running, streaking, sagging, or spotting.

No materials shall exceed the maximum volatile organic solvent content (V.O.C.) allowed by the current Federal and State laws governing their use in the State of Alabama.

855.02 Storage.

(a) All materials and their components shall be amply protected from all forms of damage at all times. All materials shall be stored in tightly covered unopened containers at a temperature range recommended by the manufacturer of the product.

(b) Storage space for all materials shall be acceptable to the Engineer. Improper storage conditions may cause the rejection of the material stored therein.

855.03 Identification and Certification.

(a) Each container shall bear a label on which shall be complete written instructions and precautions for use, the date of manufacture, the batch and/or lot number, the designation of the product, and recommended coating thickness.

(b) Each shipment of these materials shall be accompanied by written certification from the manufacturer stating that the material furnished complies with the applicable specifications. The certification shall show the designation of the product, the batch and/or lot number, and the project number.

(c) Each system of inorganic zinc primer used on bolted connection surfaces (faying) shall be qualified in accordance with "Testing Method to Determine The Slip Coefficient For Coatings Used In Bolted Joints" as adopted by the Research Council On Structural Connections. This qualification is required for the systems shown on List III-1 in the Materials Sources and Devices with Special Acceptance Requirements manual. See Appendix A of Allowable Stress Design Specification For Structural Joints Using ASTM A 325 {A 325M} or ASTM A 490 {A 490M} Bolts published by the Research Council On Structural Connections. All inorganic zinc primers shall have a minimum slip coefficient of 0.33 unless shown otherwise on the bridge plans.

855.04 Resampling and Retesting.

(a) Coating systems for structural steel will be approved on the basis of field testing as outlined in List III-1 of the Department's manual "Materials, Sources, and Devices with Special Acceptance

Requirements". Components of each batch will be sampled at the project level or fabrication plant for selective verification testing of those parameters listed in the Procedure for List III-1.

(b) The right is reserved to inspect, resample, and retest any previously approved material at any time when it is deemed expedient by the Engineer.

(c) Materials stored in accordance with the recommendations of the manufacturer may be used at any time up to the expiration date printed on the material container. Materials not used prior to the expiration date must be retested and reapproved before their use will be allowed.

855.05 Coating Systems For Structural Steel.

The Department has established several types of coating systems according to the anticipated environmental conditions as well as the required surface preparation. The list is divided into various coating systems which have been approved for each of these types through actual field use or field and/or laboratory tests conducted by approved Governmental Agencies. These are multiple coat systems of production run materials from various coating manufacturers. This list is found in the Department's "Materials, Sources, and Devices with Special Acceptance Requirements" manual, List III-1. The requirements for the use of products from this list are found in its accompanying procedure. A copy of the list and its accompanying procedure are available from the Bureau of Materials and Tests.

The following will apply when the condition exists where a coating system, produced by a manufacturer not initially listed on List III-1, is proposed for use:

(a) The manufacturer of the coating shall request that the Department approve the coating system according to the procedure referred to above.

(b) In lieu of the completed field test, the manufacturer shall be required to demonstrate to the Department that the system can be successfully applied.

(c) Upon demonstration of a successful application, the Department may give temporary approval to the coating system until time allows for the system to complete a performance field test.

(d) Upon successful completion of the field test, the coating system will be added to List III-1.

(e) The Department will monitor the applied coating system during this interim period (until field testing is complete) for any cracking, peeling, blistering, or loss of adhesion between the substrate or any layer which will be cause for revocation of the temporary approval.

The required type of system will be specified on the contract plans for individual projects. Contractors may select any system listed from the specified type of system. Only systems on this list shall be furnished for use. Systems are comprised of multiple products representing the various coats required. Products must be used with their counterparts in that system only. Mixing of products from different systems will not be allowed. The number of coats is specified on the list. Coating thickness shall be as recommended by the producer of the material with conformance checked in accordance with standard SSPC-PA2. All coatings shall be applied in accordance with the manufacturer's recommendations using spray equipment suitable for the coating unless otherwise specified.

To allow ease of visual inspection, the prime coat shall be a color to contrast the cleaned steel surface and each coat in the system shall be of a color which will contrast the other layers in contact with it. The topcoat for non-weathering steel shall be a green color matching Federal Standard 595 Chip 24272 unless otherwise specified. The topcoat for the partial painting of weathering steel shall be a brown color matching Federal Standard 595 Chip 30045 unless otherwise specified. High solids aluminum mastic coatings will not be required to be colored, unless otherwise specified.

855.06 Timber and Wood Paints.

The following primer, second, and third coat paints shall meet the production specification indicated below. Unpainted work and old painted surfaces in poor condition shall be painted with one coat of primer FSS TT-P-25. These paints have different uses according to the area in which they are used and whether they are to be tested or not.

855.07 Primer (Wood).

FSS TT-P-25.

855.08 Outside White.

AASHTO M 70, Type 2.

855.09 Outside Black.

FSS TT-E-489.

Intended for the top or finish coat on previously primed wood or metal.

855.10 Paint For Concrete and Masonry.

FSS TT-P-24.

Type I - White only.

Type II - Tint-base-white for tinting. Primarily intended to be used as a primer and finish coat on outside surfaces. It can be used inside over suitable primed concrete, brick, stucco, and similar surfaces except floors. The dried coat is an eggshell color.

855.11 Paint For Masonry.

FSS TT-P-19.

Acrylic Emulsion Type, for exterior use.

855.12 Olive-Drab (Exterior).

FSS TT-P-81.

855.13 Green Exterior Paint.

FSS TT-E-489.

855.14 Enamel (Exterior).

FSS TT-E-489.

Class A - Air-drying.

Class B - Baking.

This enamel gives a high-gloss finish to be used over previously primed smooth wood or metal surfaces. Color selection is wide. It is suitable for signs and automotive equipment.

855.15 Zinc Coating for Galvanization and Coating Repair.

The zinc coating used for the repair of damaged galvanization and the repair of zinc coatings shall be one of the coatings given under the classification "Zinc-Rich Coating for Repairing Galvanized Items or Zinc Coatings" shown in List III-1 "Coating Systems for Structural Steel."

855.16 Asphalt Varnish.

FSS-TT-V-51.

855.17 Shellac Varnish.

FSS TT-S-300.

855.18 Spar Varnish.

FSS TT-V-121.

SECTION 856
TRAFFIC MARKING MATERIALS

856.01 Acceptance Program for Traffic Marking Materials.

The guidelines for the evaluation and acceptance of traffic marking materials are given in the procedure ALDOT-420 "Acceptance Program for Traffic Marking Materials". These guidelines shall be followed in furnishing traffic marking materials.

856.02 Packaging and Labeling of Containers.

Traffic marking materials shall be shipped in containers that are plainly marked with the weight in pounds per gallon {kilograms per liter}, the volume in gallons {liters}, the color, user information, date of manufacture, lot and batch number. Each batch shall have a unique number. A statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer shall also be shown. The label shall contain any instructions for special handling or precautions for use of the material that are recommended by the manufacturer. Containers with inadequate indentification and marking will not be accepted for use.

The date of manufacture and the shelf life shall be shown for materials that have a shelf life.

Preformed thermoplastic materials and permanent tape products shall be marked with content, color, date of manufacture and lot number.

856.03 Color and Luminance Factor

The materials for pavement stripe, markings and legends shall meet the performance requirements given in ASTM D 6628 as tested in accordance with the requirements given in ASTM E 1349 with the instrument set to read x, y and Y coordinates with 45 degree/0 degree by-directional geometry, observer angle 2 degrees, and illuminant D65 with the exception of the following:

The initial daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Initial Daytime Chromaticity Coordinates (Corner Points)				
	1	2	3	4
X	0.498	0.557	0.479	0.438
Y	0.412	0.442	0.520	0.412

The initial daytime chromaticity for white materials shall fall within the box created by the following coordinates:

Initial Daytime Chromaticity Coordinates (Corner Points)				
	1	2	3	4
X	0.330	0.368	0.340	0.274
Y	0.300	0.366	0.393	0.329

White and yellow materials shall meet the following luminance factor requirements:

- White: Daylight luminance factor at 45 degrees/0 degrees - 50 % minimum;
- Yellow: Daylight luminance factor at 45 degrees/0 degrees – 35 % minimum.

856.04 Environmental Requirements.

All yellow materials using lead chromate pigments shall meet the criteria of non-hazardous waste as defined by 40 CFR 261.24 when tested in accordance with EPA Method 1311, Toxicity Characteristics Leaching Procedures (TCLP). The striping and marking material, upon preparation and installation, shall not exude fumes which are toxic, or detrimental to persons or property. All material using lead free pigments shall NOT contain either lead or other Resource Conservation and Recovery Act (RCRA) materials, in excess of the standard defined by EPA Method 3050 and 6010.

856.05 Glass Beads.

Glass Beads shall meet the requirements given in AASHTO M 247 and shall not contain greater than 200 ppm (total) for arsenic, 200 ppm (total) for antimony, and 200 ppm (total) for lead when tested according to US EPA Method 3052 and 6010. The manufacturer shall provide independent certified test results that the glass beads meet these requirements. Type 1, 3 and 4 glass beads used for drop on beads shall be coated with a bead coating that is compatible with the traffic marking material to which the glass beads will be applied and will provide adequate moisture proofing, increased adhesion, and optimum embedment of the glass beads. Beads used in the intermix (premixed with paint, thermoplastic or other striping materials) are not required to be coated.

Glass beads shall meet the gradations shown in the following table.

GRADATIONS OF GLASS BEADS, % PASSING DESIGNATED SIEVE						
Sieve Size *	Type of Gradation					
	Type 1	Type 3	Type 4	3M "Reflective Elements" S series	50 % Type 1 and 50 % Type 3 Intermixed	50 % Type 1, 37.5 % Type 3 and 12.5 % 3M "Reflective Elements" Intermixed
10			100	100		100
12		100	95 - 100	85 – 100	100	
14		95 - 100	80 - 95	70 - 96	95 – 100	95-100
16	100	80 - 95	10 - 40	50 - 90	85 – 100	85-100
18		10 - 40	0 - 5	5 - 60	55 – 75	50-75
20	95 - 100	0 - 5	0 - 2	0 - 25	40 – 60	45-55
25		0 - 2			40 - 60	
30	75 - 95			0 - 7	35 – 55	35-50
40						
50	15 - 35				5 – 25	5-20
80						
100	0 - 5				0 - 5	0-5
* Sieve analysis in accordance with the requirements given in ASTM D 1214						

856.06 Class 1 Paint.

Class 1 paint shall be one of the materials shown on List V-4, Permanent Traffic Marking Materials. List V-4 is in the Department's Manual, "Materials, Sources and Devices with Special Acceptance Requirements". Manufacturers of Class 1 paint shall participate in ALDOT-420, "Acceptance Program for Traffic Marking Materials".

856.07 Class 1H High Build Paint.

Class 1H paint shall not be used after the expiration of the shelf life. The paint shall be easily stirred and mixed to a uniform consistency prior to use.

Manufacturers of Class 1H paint shall participate in ALDOT-420, "Acceptance Program for Traffic Marking Materials".

Class 1H High Build Paint shall meet the following requirements.

PHYSICAL AND PERFORMANCE REQUIREMENTS FOR HIGH BUILD TRAFFIC PAINT		
PROPERTY	VALUE	TEST METHOD
Acrylic Resin	100 % Rohm & Haas Rhoplex Fastrack HD-21A emulsion with 48.5 – 49.5 % solids content, or Dow DT 400NA acrylic emulsion with 49.5 – 51.5 % solids content, or an approved equal.	ASTM D 2743 Infrared Spectral Analysis
Nonvolatiles in Vehicle	42 % Minimum by Weight	ASTM D 215
No Track Time	Maximum of 10 minutes	ASTM D 711
Volatile Organic Content	Maximum of 1.25 Pounds per Gallon	ASTM D 3960
Pigment Content	Minimum of 55% by Weight Maximum of 62% by Weight	ASTM D 3723
Total Solids Content	Minimum of 73 % by Weight Maximum of 79 % by Weight	ASTM D 2369
White Pigment Content, Rutile Titanium Dioxide	Minimum of 1.0 Pound per Gallon	ASTM D 476
Yellow Pigment Content, Hansa Yellow (11-2400)	% minimum per manufacturer	-
Viscosity @ 77ºF (25ºC) Kreb Units	78 – 95	ASTM D 562
Density in Pounds per Gallon	White – 13.7 Minimum Yellow – 13.1 Minimum	ASTM D 1475
Scrub Resistance	Pass Minimum 300 cycles	ASTM D-2486
PH	9.6 Minimum	ASTM E 70
Daylight Reflectance %	White – 80 Minimum Yellow – 50 Minimum	ASTM E 1349

856.08 Class 2 and Class 2T Spray Applied Thermoplastic.

Thermoplastic shall be alkyd based materials. Manufacturers of Class 2 and Class 2T Thermoplastic shall participate in ALDOT-420, "Acceptance Program for Traffic Marking Materials".

Reflective glass beads shall be mixed into the thermoplastic as a part of the manufacturing process. The intermixed glass beads shall be either 50 % Type 1 and 50 % Type 3 beads or 50% Type 1, 37.5 % Type 3, and 12.5 % 3M "Reflective Elements". The pigment, glass beads and filler shall be well dispersed in the resin. The composition of Class 2 and Class 2T thermoplastic material shall be in accordance with the following.

COMPOSITION OF CLASS 2 and CLASS 2T THERMOPLASTIC (% BY WEIGHT)				
COMPOSITION	VALUE FOR WHITE	VALUE FOR YELLOW (Lead Free)	VALUE FOR YELLOW (Leaded)	TEST METHOD
Binder	20.0 % minimum	20.0 % minimum	20.0 % minimum	AASHTO T 250
White Pigment TiO2, Type II Rutile	10.0 % minimum	-	1.5 % minimum	ASTM D 476
Glass Beads (Intermixed)	40.0 % minimum	40.0 % minimum	40.0 % minimum	AASHTO T 250
Yellow Pigment, Lead Chromate	-	N/A	5.0 % minimum *	AASHTO T 250
Yellow Pigment, Organic Pigment Yellow 83	-	% minimum per manufacturer **	N/A	-
Calcium Carbonate and Inert Filler (-200 mesh {-75 µm} sieve)	30.0 % maximum	37.5 % maximum	33.5 % maximum	ASTM D 1199
* Note: For yellow leaded thermoplastic markings the pigment shall be silica encapsulated lead chromate yellow, containing a minimum of 42 % lead. ** Note: For yellow lead free markings the pigment shall be an organic pigment yellow 83. The lead free yellow thermoplastic material shall contain no more than 100 ppm of lead, cadmium, or hexavalent chromium.				

The physical requirements for the thermoplastic shall be in accordance with the following.

PHYSICAL REQUIREMENTS OF CLASS 2 and CLASS 2T THERMOPLASTIC (% BY WEIGHT)			
PROPERTY	MAXIMUM	MINIMUM	TEST METHOD
Water Absorption	0.5 %	-	ASTM D 570
Softening Point	-	195 ºF {90 ºC}	ASTM D 36
Low Temperature Stress Resistance	-	Pass	AASHTO T 250
Specific Gravity	2.3	1.9	ASTM D 792
Indentation Resistance	75	40	ASTM D 2240* Shore Durometer, A2
Impact Resistance	-	1.0 N·m	ASTM D 256, Method A
Flash Point	-	475 ºF {245 ºC}	ASTM D 92
*The durometer and panel shall be at 110 ºF {45ºC} with a 4.4 lb {2.0 kg} load applied. Instrument measurement shall be taken after 15 seconds.			

856.09 Preformed Thermoplastic

Preformed Thermoplastic shall be alkyd based materials. Manufacturers of Class 2 Preformed Thermoplastic shall participate in ALDOT-420, "Acceptance Program for Traffic Marking Materials".

Preformed Thermoplastic shall conform to all physical and composition requirements of Class 2 and 2T Thermoplastic with the exception that preformed Thermoplastic shall contain 30% intermix glass beads.

SECTION 857
TEMPORARY TRAFFIC MARKING MATERIALS

857.01 General.

The Department has established a list of products approved for use through field tests. These products can be found on List V-3, Temporary Traffic Marking Materials. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355. The Contractor may choose from any of these products, unless otherwise noted. Although the product durability has been approved, acceptance of the material will still be based on laboratory testing as outlined in List V-3 and the Department's Testing Manual.

SECTION 860
ROADSIDE IMPROVEMENT MATERIALS

860.01 Seed.

(a) Pure Seedings.

1. Testing and Certification.

Seeds shall be certified by an Official Seed Certifying Agency. Seeds shall have been tested within nine months prior to use. Each kind of seed shall be separately packed and delivered to the project in a seed-tight bag. Each bag shall bear a tag or label bearing the seal of the Official Seed Certifying Agency.

The analysis of the seed (% pure seed, % germination, date tested, etc.) shall be attached to each bag. Seed shall be at least 95 % pure seed of the required type. Seed for lespedezas shall have a minimum germination rate of 80 %. Seed for all other species shall have a minimum germination rate of 85 %.

2. Sampling and Verification Testing.

Samples of seeds may be taken at any time by the Engineer. Tags or labels that have the analysis of the seeds will be placed with the samples taken by the Engineer. The samples will be stored by the Engineer until a satisfactory stand of grass is obtained. If it is apparent that germination or other problems exist in the establishment of the ground cover, the samples will be submitted to the Alabama Department of Agriculture for testing.

3. Hulled and Scarified Seeds.

Bermudagrass may be either hulled or unhulled as shown in the table of seed mixes.
Sericea Lespedeza shall be hulled and scarified.
Annual Lespedeza (Kobe), White Dutch Clover, and Reseeding Crimson Clover shall be hulled.

4. Coated Seeds.

Coated seeds will not be accepted for planting unless noted otherwise on the plans.

(b) Seed Mixes Designated for Areas of Frequent Mowing.

Some seed mixes are designated for "AREAS SUBJECT TO FREQUENT MOWING". Areas subject to frequent mowing are roadway shoulders, medians and front slopes flatter than 3:1 extending 60 feet beyond the edge of pavement or to the toe of the front slope whichever is less. All other areas designated for seeding shall be considered to be "AREAS NOT SUBJECT TO FREQUENT MOWING".

(c) Planting Zones.

The State of Alabama is divided into three planting zones as shown in the following table:

ZONE 1		ZONE 2		ZONE 3	
Blount	Lauderdale	Autauga	Montgomery	Baldwin	Marengo
Calhoun	Lawrence	Bibb	Perry	Barbour	Mobile
Cherokee	Limestone	Bullock	Pickens	Butler	Monroe
Clay	Madison	Chambers	Russell	Choctaw	Pike
Cleburne	Marion	Chilton	Sumter	Clarke	Washington
Colbert	Marshall	Coosa	Tallapoosa	Coffee	Wilcox
Cullman	Morgan	Dallas	Tuscaloosa	Conecuh	
Dekalb	Randolph	Elmore		Covington	
Etowah	Shelby	Greene		Crenshaw	
Fayette	St. Clair	Hale		Dale	
Franklin	Talladega	Lee		Escambia	
Jackson	Walker	Lowndes		Geneva	
Jefferson	Winston	Macon		Henry	
Lamar				Houston	

(d) Seed Mixes.

Seed mixes shall be mixtures of the types of seeds shown in the following tables. The required weight shown in the chart is the actual seed weight as delivered and takes into account the minimum required percentage of pure seeds and minimum required germination rates.

ZONE 1 - AREAS SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Aug. 16 to Feb. 29		Mar. 1 to May 15	May 16 to August 15
Annual Ryegrass	10 {11}	25 {28}		
Hulled Bermudagrass			18 {20}	24 {27}
Unhulled Bermudagrass	30 {34}		12 {13}	
Annual Lespedeza (Kobe)				38 {43}
White Dutch Clover	5 {6}		6 {7}	
Notes	1	2		
Required Permanent Plant	Bermudagrass			
1. During this season Ryegrass, Bermudagrass and Clover are required where vegetation must be established within an area no further than 15 feet {3 m} from the edge of mainline pavement. (This is usually required for short duration work that is done on pavement resurfacing projects.) 2. Annual Ryegrass is required where vegetation must be established within an area that extends further than 15 feet {3 m} from the edge of mainline pavement. Seeding in stubble for the establishment of permanent vegetation is required during the following month of March.				

ZONE 1 - AREAS NOT SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Jan. 1 to Feb. 29	Mar. 1 to August 15	Aug. 16 to Nov. 15	Nov. 16 to Dec. 31
Annual Ryegrass	15 {17}			15 {17}
Hulled Bermudagrass		18 {20}		
Unhulled Bermudagrass	35 {39}	12 {13}	18 {20}	35 {39}
Tall Fescue	35 {39}	35 {39}	35 {39}	35 {39}
Weeping Lovegrass		2 {2}		
Hulled Sericea Lespedeza		38 {43}	38 {43}	
Unhulled Sericea Lespedeza	38 {43}			38 {43}
Reseeding Crimson Clover			29 {33}	
Required Permanent Plant	Mixed			

ZONE 2 - AREAS SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Aug. 16 to Feb. 29		Mar. 1 to Apr. 15	Apr. 16 to Aug. 15
Annual Ryegrass	10 {11}	25 {28}		
Hulled Bermudagrass			18 {20}	24 {27}
Unhulled Bermudagrass	30 {34}		12 {13}	
Annual Lespedeza (Kobe)				38 {43}
White Dutch Clover	5 {6}		6 {7}	
Notes	1	2		
Required Permanent Plant	Bermudagrass			
1. During this season Ryegrass, Bermudagrass and Clover are required where vegetation must be established within an area no further than 15 feet {3 m} from the edge of mainline pavement. (This is usually required for short duration work that is done on pavement resurfacing projects.) 2. Annual Ryegrass is required where vegetation must be established within an area that extends further than 15 feet {3 m} from the edge of mainline pavement. Seeding in stubble for the establishment of permanent vegetation is required during the following month of March.				

ZONE 2 - AREAS NOT SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Jan. 1 to Feb. 15	Feb. 16 to Aug. 31	Sept. 1 to Nov. 15	Nov. 16 to Dec. 31
Annual Ryegrass	10 {11}	5 {6}	10 {11}	10 {11}
Hulled Bermudagrass		18 {20}	12 {13}	
Unhulled Bermudagrass	24 {27}	12 {13}	12 {13}	24 {27}
Tall Fescue	29 {33}		35 {39}	29 {33}
Weeping Lovegrass		2 {2}	2 {2}	
Annual Lespedeza (Kobe)		50 {56}		
Reseeding Crimson Clover	29 {33}		29 {33}	29 {33}
Pensacola Bahia Grass	29 {33}	29 {33}	29 {33}	29 {33}
Required Permanent Plant	Mixed			

ZONE 3 - AREAS SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Sept. 1 to Feb. 29		Mar. 1 to Aug. 31	Mar 1. to Aug. 31
Annual Ryegrass	10 {11}	25 {28}		
Hulled Bermudagrass		*	18 {20}	
Unhulled Bermudagrass	30 {34}		12 {13}	12 {13}
Annual Lespedeza (Kobe)			38 {43}	24 {27}
Pensacola Bahia Grass				47 {53}
Reseeding Crimson Clover	5 {6}			
Notes	1	2	3	3
Required Permanent Plant	Bermudagrass			Pensacola Bahia Grass

1. During this season Ryegrass, Bermudagrass and Clover are required where vegetation must be established within an area no further than 15 feet {3 m} from the edge of mainline pavement. (This is usually required for short duration work that is done on pavement resurfacing projects.)
2. Annual Ryegrass is required where vegetation must be established within an area that extends further than 15 feet {3 m} from the edge of mainline pavement. Seeding in stubble for the establishment of permanent vegetation is required during the following month of March.
3. Bermudagrass will be required as the permanent plant if it is not shown on the plans that Pensacola Bahia Grass will be required as the permanent plant.

ZONE 3 - AREAS NOT SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Jan. 1 to Feb. 15	Feb. 16 to Aug. 31	Sept. 1 to Nov. 30	Dec. 1 to Dec. 31
Annual Ryegrass	10 {11}		10 {11}	10 {11}
Hulled Bermudagrass		12 {13}	12 {13}	
Unhulled Bermudagrass	29 {33}	18 {20}	12 {13}	29 {33}
Tall Fescue	29 {33}		35 {39}	29 {33}
Weeping Lovegrass		2 {2}	2 {2}	
Annual Lespedeza (Kobe)		50 {56}		
Reseeding Crimson Clover	29 {33}		29 {33}	29 {33}
Pensacola Bahiagrass	29 {33}	24 {27}	29 {33}	29 {33}
Required Permanent Plant	Mixed			

860.02 Grass Sprigs.

(a) General.

This Article is based on the use of sprigs; however, should the Contractor elect to use plugs of sod, the same basic requirements are applicable except that harvesting shall be in accordance with the provisions of Article 860.05 for solid sod, which in turn shall be cut to proper size (at least 2 inches by 2 inches {50 mm by 50 mm}) by an acceptable procedure before use.

Grass sprigs or plugs of sod turfs shall be common or Tiflawn Bermudagrass, Centipede, Myers Zoysia, Zoysia Matrella, or other perennial running grasses that may be indicated by the plans. All grass shall be native or adaptable to the locality of the work and shall be live, fresh, vigorous, and uninjured at the time of planting and until completion and acceptance of the work. The sprigs shall have well formed and developed root systems and shall be in clusters or tufts at least 1 inch {25 mm} in diameter unless otherwise directed. Sprigs containing Johnsongrass, Bahiagrass, Dallasgrass, or other objectionable grasses or weeds will not be accepted.

(b) Procuring and Handling Sprigs.

Before harvesting, the Engineer shall be notified of the source of sprigs for purposes of inspection. Approval of sources on such examination shall not be construed as an acceptance of the material.

Unless the grass area has been grazed closely, it shall be mowed to height of 3 inches {75 mm} maximum before harvesting. The sprigs shall be harvested with a sod-cutter, turning plow, or other approved implements in such a manner that at least 2 inches {50 mm} of the root system will be lifted intact. Raking and otherwise harvesting sprigs that remain on the surface after digging and have been allowed to dry out, will not be permitted. Solid sod specified in Article 860.05 may be pulled apart and used as sprigs.

The properly harvested sprigs shall be loaded within one hour after they are dug then transported to the place where they are to be planted. They shall be kept cool, moist and shaded at all times after digging, while being transported to the sprigging site, after being unloaded, and until planted. Small quantities of sprigs left over at the end of the work day or at time of heavy rains may be stocked in thin covered piles and may be used the next day or not over three days later, provided sprigs in the pile are still acceptable. The sprigs will be subject to inspection during the planting period, and any material which has been permitted to dry out or to freeze, or which is not moist and viable, will be rejected.

When large pieces of sprigs are to be broken down into smaller pieces for sprigging, this operation shall be done by hand or by such other means that will avoid severing the roots from the tops of the sprigs.

After unloading, accepted sprigs shall be carried to the planting site in moist cloth or burlap bags and kept therein until ready to be dropped into the furrows.

860.03 Mulching Material.

(a) Dry Blown Mulch.

Dry blown mulch shall be hay or straw applied at rates required in Section 656. Hay shall be native hay or Sudan grass, broom straw, coastal bermudagrass, or other materials approved by the Engineer. Straw shall be threshed straw of oats, wheat, or rye. Mulch materials shall not contain an excessive quantity of matured seeds or noxious weeds or a species which would constitute a menace to the planted species and to surrounding farm land. Mulch shall not be too fresh, or excessively brittle, or so decomposed as to retard growth of grass.

The moisture content of the mulch shall not exceed 15 % at the time that the mulch is weighed. Moisture content will be checked as directed by the Engineer.

The moisture content of the mulch will be checked in accordance with ALDOT Procedure 240, "Determination of Moisture Content in Mulching Materials".

Acceptable Tackifier Adhesives are listed on List II-20, “TACKIFIERS, MULCH CONTROL NETTING, AND HYDRAULIC MULCH PRODUCTS”, of the Department's manual "Materials, Sources, and Devices with Special Acceptance Requirements". Tackifiers shall be used at the manufacturer's recommended rates when chosen for mulch stabilization. Tackifiers shall be harmless to fish, wildlife, and plants, and shall be non-toxic and non-combustible as documented through Material Safety Data Sheets and a 7 day chronic Ceriodaphnia reproduction test report. Asphalt adhesives are not acceptable for use.

Acceptable Mulch Control Netting products are listed on List II-20, “TACKIFIERS, MULCH CONTROL NETTING, AND HYDRAULIC MULCH PRODUCTS”, of the Department's manual "Materials, Sources, and Devices with Special Acceptance Requirements". Mulch Control Netting shall be 100% biodegradable, be of a uniform, open, plain weave and meet the following requirements:

- Minimum Mass per Unit Area of 9 ounces per square yard (ASTM D 5261)
- Minimum Tensile Strength (Machine Direction, Dry) of 300 pounds per foot (ASTM D 4595)
- Minimum Tensile Strength (Transverse Direction, Dry) of 125 pounds per foot (ASTM D 4595)
- Minimum 50% Open Area as determined by physical measurement.

(b) Hydraulic Mulch Products.

Hydraulic Mulch Products shall consist of natural fibers with or without tackifier adhesives and/or binding agents. It shall be processed in such a manner that it will contain no growth or germination inhibiting factors and shall be dyed an appropriate color to facilitate a uniform spread of the slope by visual inspection. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with soil amendments, the fibers in the material will become uniformly suspended to form a homogeneous slurry; and that when hydraulically sprayed on the ground, the material will form a ground cover; and which after application will allow the absorption of moisture and allow rainfall or mechanical watering to percolate to the underlying soil.

Hydraulic Mulch Products shall have a maximum RUSLE Cover Factor (C-Factor) of 0.20 defined as the ratio of the soil loss from a slope protected by the product to the soil loss from an unprotected or

bare soil slope. At a minimum, one slope test replicate of ASTM D 6459-07 shall be conducted at an independent laboratory accredited by the Geosynthetic Institute's, Geosynthetic Accreditation Institute's-Laboratory Accreditation Program (GAI-LAP) for this test. The Hydraulic Mulch Product shall have a minimum 200 % Vegetation Enhancement compared to the control and shall be measured in accordance with the requirements given in ASTM D 7322.

Acceptable Hydraulic Mulch Products are listed on List II-20, "TACKIFIERS, MULCH CONTROL NETTING, AND HYDRAULIC MULCH PRODUCTS", of the Department's manual "Materials, Sources, and Devices with Special Acceptance Requirements". All packaging of the mulch shall be clearly marked with the lot or batch number, material specifications, and application recommendations. Weight {mass} specifications of this material shall refer only to air dry weight {mass} of the fiber material.

860.04 Grassy Mulch Material.

(a) General.

Grassy mulch shall be obtained from the sources of the Contractor's selection and meeting the approval of the Engineer. The Contractor shall furnish such material and construct and maintain hauling roads necessary for obtaining the material, all without extra compensation.

The grass contained in the grassy mulch material shall be live growing grass as provided in Article 860.02 and shall be procured from areas where the soil is fertile as indicated by vigorous growth. The grass shall have a healthy virile root system of dense, thickly matted roots. It shall be reasonably free from obnoxious weeds or other grasses, and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. The soil part of the mulch shall be the topsoil in which grass is growing and may include the 2 inches {50 mm} immediately underlying the root system provided it is identical topsoil and no part of the less friable subsoil is taken.

(b) Harvesting and Handling Grassy Mulch.

1. Harvesting Operations.

Grassy mulch shall be taken only from an approved source. The grassy mulch shall be procured only when the soil is in a moist, friable condition. During extremely dry periods it may be necessary to water the areas from which mulch is to be taken. Previous to any other manipulations, these areas shall be grubbed clear of any bushes or stubs and closely mowed and raked to remove all weeds and long standing stems. The material thus cleaned from the sites shall be burned. Such cleaning is deemed a necessary part of this Item and not considered under the Item of "Clearing and Grubbing." If directed, this operation may be omitted if the grass is sufficiently short and the area satisfactorily cleared of obstructions. After grubbing, mowing and raking, and sprinkling, if considered necessary, the grass shall be disced until the sod has been well mangled and the topsoil loosened to the depth it is to be taken. After discing, the grassy mulch shall be cast into windrows by an approved tractor-drawn or motor-powered blade grader.

2. Loading.

The well mixed topsoil and grass roots shall be loaded into trucks by hand shovels, power shovels, drag lines, or other mechanical loading devices. No grassy mulch shall be loaded which has been disced, but not windrowed, more than six hours or which has been windrowed more than 24 hours unless the loading operations have been interrupted by rain in sufficient quantity to wet the grassy mulch and make work impracticable. Loading shall be resumed as soon as practicable after such rain ceases. All material windrowed prior to such rain shall be loaded and placed within 24 hours after such rain ceases. In no case shall grassy mulch be used in which the grass has soured, mildewed or started to decay.

860.05 Solid Sod.

(a) General.

Solid sod shall be obtained from sources of the Contractor's selection meeting with the approval of the Engineer. The Contractor, without extra compensation, shall furnish such material and construct and maintain hauling roads necessary for obtaining the material.

The sod shall be of common Tiflawn Bermudagrass, Centipede, Myers Zoysia, Zoysia Matrella, or other approved types of native or adaptable grasses, suitable for growing in the locality of the work.

(b) Procuring and Handling Sod.

1. General.

All sod shall be procured from areas where the soil is fertile and contains a high percentage of loamy topsoil and where the grass is well rooted and full grown and from areas that have been grazed or mowed sufficiently to form a dense turf. (Approximately 2 inches {50 mm} in height at the time of lifting). The soil shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to its growth. Solid sodding shall be living or seasonally dormant during the cold or dry season and have an established root system capable of continued growth. Solid sodding grown with a geotextile backing is acceptable for use at the Contractor's option with no additional compensation. Solid sodding used in channel applications shall be rolled sod.

2. Harvesting.

Mechanical devices, such as sod cutters, may be used for cutting the sod into strips, blocks or rolls at least 12 inches {300 mm} wide, except when sod strips are specified, then they shall be at least 3 inches {75 mm} wide. Depth of sod cutting shall be such that approximately 3/4 of an inch {19 mm} of soil is removed with the turf. Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of excavating, hauling, and planting.

3. Handling.

Sections of sod shall be cut away below the root line and shall be lifted and loaded in such a manner that no tearing or breaking will occur, and unloaded by hand or approved mechanical method. Dumping from vehicles will not be permitted. All broken or dried sod shall be rejected and removed from the job.

4. Control.

The sod shall, in general, be transplanted within three days from the time it is harvested. However, if held in temporary storage, the sod shall be spread in a shady location with the grass side up. The sod shall be sprinkled with water when and as directed. If required, it shall be covered with moist burlap, straw, or other acceptable material. Any sod permitted by the Contractor to dry out may be rejected whenever, in the judgment of the Engineer, its survival, after placing, shall have been rendered doubtful and no payment for such sod shall be made.

In no event shall more than 10 days elapse between the cutting and planting of the sod.

Prior to permitting sod planting, the Engineer will inspect the sod stacks for retention of native soil. Such may be accomplished by measuring the stack height and determining the average layer thickness (3/4 of an inch {19 mm} minimum).

860.06 Vines, Shrubs and Trees.

(a) General.

1. The scientific and common names of plants shall be in conformity with the approved names in "Standardized Plant Names" (current edition) prepared by the American Joint Committee on Horticultural Nomenclature.

2. Plants shall be in accordance with the American Standards for Nursery Stock (current edition), except as provided on the plans. All plants shall have normal habit of growth and shall be typically characteristic of the particular variety and species. All plants shall conform to the measurements provided, which are the minimum acceptable sizes. They shall be measured before pruning with branches in normal position. When a minimum and maximum size is provided, an average size is required. Deciduous trees shall be measured by approved calipers. Plants which hare been cut back from larger grades to meet these Specifications will not be acceptable. Plants shall be nursery grown and shall bear evidence of proper top and root pruning unless otherwise provided. No cold storage plants will be accepted. Plants shall have been growing for a period of at least one year under the same climatic conditions as exist at the location to be planted. Where the Specifications or plans permit, planting stock which has been collected, such stock shall be clean, sound stock free from decayed or decaying stumps and from fire injury.

3. For purpose of inspection, the Contractor shall give notice to the Engineer 48 hours in advance of the delivery of plant material. The Contractor shall be responsible for all certificates of inspection of plant materials that may be required by Federal, State or other authority to accompany shipments of plants. All plants shall be subject to inspection and approval by the Engineer at any place and at any time. Plants may be inspected where growing, but approval at place of growth shall not preclude the right of subsequent rejection of plants not fully meeting the requirements of the Specifications. After the award is made, the Engineer reserves the right to place Department seals on any and all materials

selected, but such tagging and approval shall cover the type and body quality of the plant only, but not final acceptance. The removal and replacement of rejected plants shall be effected by the Contractor in compliance with the Specifications and shall be without extra compensation.

4. Plants and plant qualities other than those named in the Specifications will be accepted only if approved.

5. Legible labels shall be attached to all separate plants or boxes, bundles, bales, or other containers, indicating the name, size, age, or other necessary detailed information and the quantity contained in the individual bundles, boxes or bales.

(b) Planting Limitations.

Normal planting season for vines, shrubs, and trees is between December 1 and February 15 and the Contractor shall make every effort to accomplish the planting during this period. Should, however, the contract time be such that plants cannot be placed during this period, the Engineer shall direct the placement of the plants at the earliest possible time the plant areas can be made available. Under conditions that require or if the Contractor elects to place the plants out of the normal planting season, all plants shall be container grown or pre-cured and planted in accordance with the following:

Container Grown.

Container grown plants shall have been grown in its container for a minimum of eight months.

After plants are moved to their permanent location, they shall be watered in as specified, mulched, etc. Syringing down of the leaf areas shall be performed as necessary to prevent wilting, dehydration, and excessive shedding of new or old growth. This will require a period of thirty days or longer to assure that a given plant has been successfully transplanted.

Pre-Cured.

Pre-curing of plants is a technique that allows the planting of balled or burlap plant materials during period other than in the dormant period of planting season specified. The following procedure shall generally be followed to precure or hardening off a plant.

1. Specified plants shall be dug and placed unpruned in a lath or green house.
2. The ball shall be covered with well rotted sawdust.
3. Humidity shall be maintained to such a degree that wilting or dehydration does not occur.
4. Spray nozzles shall be of mist type, connected to suitable interrupter devices if necessary, so that water logging of the plant balls does not occur.
5. After root hairs have formed, as evidenced by their emergence through the burlap, and with new and old top growth in a health, turgid condition, the plants shall be transplanted to their permanent location.
6. This pre-curing period shall be a minimum of thirty days.
7. Leaf drop or defoliation shall be limited to one-fourth the total leaves.
8. After plants are moved to their permanent location, they shall be watered, mulched, etc. Syringing down of the leaf areas shall be performed as necessary to prevent wilting, dehydration, and excessive shedding of new or old growth. This will require a period of 30 days or longer to assure that a given plant has been successfully transplanted.

Any plantings accomplished outside of the normal planting season shall be inspected regularly and any plant found defective shall be removed and immediately replaced with the same size and kind in the same manner as originally provided.

Any additional cost involved in planting out of season due either to the Contractor's inability to schedule his work properly or contract time requirements shall be considered incidental to the work and no additional compensation will be allowed.

Planting will not be permitted during periods when the ground is frozen.

(c) Digging and Transportation.

1. All plants shall be dug with reasonable care and skill immediately before shipping, avoiding all possible injury to, or loss of roots. Plants shall be of the size, and with balls or roots spread, as shown on the plans. After plants are dug, their roots shall not be permitted to dry out, and they shall not be exposed to artificial heat or freezing temperatures.

2. During transportation, all plants shall be packed or protected in such a manner as to insure adequate protection from sun, wind, and climatic or seasonal injuries. All bare-root plants shall have their roots carefully protected by wet straw, moss, or other suitable material. Tarpaulins or other covers shall be placed over plants when transported by truck or in an open freight car. Shipments made

in box cars shall be adequately ventilated to prevent sweating. The head of each tree shall be tied in carefully to prevent fracturing or cracking the branches.

3. Previous to shipment and after delivery to the project, all plants shall be properly protected. Bare-root plants shall be heeled-in in trenches with the bundles opened and the plants spaced separately and all roots covered. Balled and burlapped, and balled and platformed plants, shall have their earth balls protected by earth or wet cloth or straw. Where possible all plants shall be stored in a well-ventilated and shaded place and protected from wind and sun.

(d) Trees.

1. Trees shall be of the size and kind designated by the plans, have a straight trunk with a well-branched, symmetrical top, and with leader intact. Trees shall have no fresh cuts of limbs over 3/4 of an inch {19 mm} which have not completely calloused over, no cut back trees, and no abrasions of the bark. Trees must be free from insect and disease injury. Trees injured in transit or delivered in an unsatisfactory manner will be rejected. Trees must have good fibrous root systems. All root cuts must be cleanly cut.

2. At the time of digging, bare-root trees (B.R.) must be puddled in a clay solution of proper consistency to coat and adhere to all parts of the root system. Any tree may be supplied balled and burlapped instead of bare-root at the unit price bid.

3. Balled and burlapped trees (B & B) shall be adequately balled with firm, natural balls of sufficient size to insure the growth of the plants or cut to size shown on the plans. Balls shall be firmly wrapped with burlap or other approved strong cloth and firmly tied with rope or other satisfactory material. No balled plant will be acceptable if cracked or broken before or during the process of planting, and no plant will be acceptable which is handled by the plant itself and not by the ball. All fibrous and pliable roots encountered in trenching around the ball shall be cut off flush with the outer side of the trench, the ground in the trench loosened with spading fork, and the flexible roots shall be immediately wrapped in burlap, moss, or straw and bound against the side of the ball. Only stiff roots may be cut off flush with the ball. The ball of earth for each tree shall be of sufficient depth to include all lateral roots.

4. Balled and platformed trees (B & P) shall be balled as provided for balled and burlapped trees. Platforms shall be square or octagonal shaped in a size slightly larger than the diameter of the bottom of the soil weight {mass}, inserted under each ball and securely lashed to the ball by means of ties from the platform corners to the rope collar on top of the ball.

(e) Shrubs.

Shrubs shall be of the size and kind designated by the plans. Bare-root shrubs shall have good fibrous root systems. Balled and burlapped shrubs shall be vigorous, well furnished plants of uniform quality and must have fibrous root systems. Plants provided as sods or clumps shall be collected from good soil which has produced a fibrous root system typical of the nature of the plant. The sods shall be dug with earth and incidental vegetation adhering to the roots. If the soil or habit of the root growth is such that the roots are not adequately protected, the sods shall be wrapped in burlap or other suitable material.

(f) Vines and Perennials.

Vines and perennials shall be of the size and kind designated by the plans. Bare-root vines shall be vigorous, well furnished plants with good vigorous root systems, puddled before delivery or otherwise protected by an acceptable method. Pot-grown plants (P.G.) shall be vigorous well-developed plants, well established in pots with sufficient roots to hold the earth together intact after removal from containers and at the same time not to be root-bound. Upon permission of the Engineer due to lateness of planting in the spring season causing a hold-over of the planting of vines to the next season, the Contractor may furnish and plant potted plants of the kinds of vines designated as bare-root, provided the potted plants are at least one year old, the pots 2.5 inches {63 mm} minimum diameter, and two plants for the one ordered are furnished and planted in the same pocket holes or beds as specified. The two plants will be paid for at the unit price for one plant. Balled and burlapped vines shall be vigorous, well-developed plants. Perennials shall be field grown unless otherwise provided.

(g) Pine Seedlings.

Pine seedlings shall be Loblolly Pine for the North Alabama Planting Zone and Slash Pine in South Alabama Planting Zone, unless otherwise shown on the plans or in the proposal. Seedlings shall be approximately one year old and 6 to 12 inches {150 to 300 mm} high, except that any longleaf seedlings shall be root pruned and needle clipped.

Pine seedlings that are shipped in bales shall be protected from the sun, wind, and freezing weather at all times before planting. The bales shall be stacked loosely to permit free circulation of air and not more than two bales high. They shall be watered on arrival and every two days thereafter, or as directed. Seedlings from damaged or broken bales shall be "heeled in" by cutting V-bottom trenches approximately 6 inches {150 mm} deep, spreading the pines along the trench with the roots down. Roots shall be covered with fine soil, leaving the tops exposed. Seedlings shall be watered frequently enough to keep the soil moist.

860.07 Seed Inoculating Material.

Inoculating materials as required for coating certain legume seed immediately before sowing shall be an approved commercial culture manufactured by a reputable concern and of the culture group appropriate for the kind of seed to be treated. The material as received on the work shall be fresh stock designated for the current season, packaged and sealed to protect bacteria and insure against moisture loss.

860.08 Plant Topsoil (Topsoil For Backfilling Plant Pits).

Plant topsoil shall be composed of four parts of soil containing not more than 35% clay and not less than 15% nor more than 75% sand, one part mulching material (as defined in Subarticle 860.03(c), 8 pounds {4 kg} of 8-8-8 Commercial Fertilizer, and 5 pounds {2 kg} of agriculture limestone per cubic yard {cubic meter} (mineral additive may be adjusted to fit soil test results).

In lieu of the off-site topsoil noted above, with the approval of the Engineer, material from the plant pit modified with mineral additives as directed may be used.

860.09 Tree Root Protection Material.

The material for root protection shall be aggregate of approved quality, suitably graded from 3/8 to 5 inches {9 to 125 mm} in size. The material may be any suitable aggregate broken to suitable size, or may be gravel, crushed stone, slag, or broken concrete.

860.10 Miscellaneous Materials For General Planting Operations.

(a) Bracing and Anchor Stakes.

Bracing stakes shall be of southern yellow pine or other approved wood, sized in accordance with plan requirements. Stakes shall have a minimum allowable deflection of ten percent. All stakes shall be free from insects and fungi. Anchor stakes or deadmen shall be of the quality and sizes required for the operations calling for their use.

(b) Wire and Bracing Materials.

Wire shall be galvanized steel or aluminum, No. 9, No. 10, or No. 12, A.S.&W. gage as specified. The size and quality of cables, turnbuckles, thimbles, lag hooks, eye bolts, rods, washers, and nuts shall be as approved.

(c) Paper and Twine.

Wrapping paper for trees shall be krinkle-kraft or equal, waterproof paper, 30-30-30, in 4 inch {100 mm} strips. The tying material to be used in wrapping trees shall be jute twine not less than two ply for trees 3 inches {75 mm} or less in diameter, and three ply for trees over 3 inches {75 mm} in diameter.

(d) Tree Paint.

Paint used for tree wounds shall be approved antiseptic, waterproof, adhesive, and elastic, such as asphaltum water emulsion, gutta percha, and certain oils with a fungicide and which remains tacky for four hours and retains elasticity after setting when tested under the heat of the hand. It shall not contain kerosene, coal tar, creosote, or other material harmful to cambium or living tissue.

(e) Wire Protective Hose.

Hose shall be 1/2, 5/8, or 3/4 of an inch {13, 16, or 19 mm} in diameter, suitable for the purpose intended, or other approved material (hose may be second-handed).

(f) Burlap.

Burlap shall have a weight {mass} of at least 8 ounces per square yard {0.27 kg/m^2}.

(g) Drain Tile Pipe.

Drain tile pipe shall meet the requirements of Section 853. The diameter of the tile shall be 6 inches {150 mm} unless otherwise specified on the plans.

860.11 Rolled and Hydraulic Erosion Control Products.

(a) Types of Erosion Control Products.

1. Temporary Rolled Erosion Control Products (RECPs).

Temporary RECPs shall be composed of photodegradable or biodegradable mesh, netting fibers, yarns or twines. Components shall be mechanically interlocked or chemically bonded together to form a continuous matrix of material.

2. Temporary Hydraulic Erosion Control Products (HECPs).

Temporary HECPs shall be composed of photodegradable or biodegradable natural or polymer fibers that chemically bond together and form a continuous matrix of material.

3. Permanent Rolled Erosion Control Products (RECPs).

Permanent RECPs shall be turf reinforcement mats and shall have sufficient thickness, strength and void space for permanent erosion protection. Permanent RECPs shall have a minimum UV Stability of 80% retention of tensile strength at 500 hours of exposure measured in accordance with the requirements given in ASTM D 4355 "Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus".

(b) Required Performance of Erosion Control Products.

The types of erosion control products and the performance requirements for each product are given in the following table.

PERFORMANCE REQUIREMENTS OF EROSION CONTROL PRODUCTS

Product Application	ECP Type	Maximum Allowable C-Factor[1]	Minimum Shear Stress Capacity[2] (Pounds per Square Foot)	Minimum Vegetation Enhancement[3]
Slope	S4	0.10	-	200 %
	S3	0.05	-	
	S2	0.01	-	
	S1	0.005	-	
Channel	C2	-	2.0	200 %
	C4	-	4.0	
	C6	-	6.0	
	C8	-	8.0	
	C10	-	10.0	

NOTE 1: The C-Factor shall be measured in accordance with the requirements given in ASTM D 6459-07 "Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion". The C-Factor is the cover factor as commonly used in the Revised Universal Soil Loss Equation and is defined as the ratio of the soil loss from a slope protected by the ECP to the soil loss from an unprotected or bare soil slope, as reported by the American Association of State Highway and Transportation Officials, National Transportation Product Evaluation Program, Erosion Control Products (AASHTO NTPEP).

NOTE 2: The Shear Stress Capacity of an ECP shall be measured in accordance with the requirements given in ASTM D 6460-07 "Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion". The Shear Stress Capacity is defined as the limiting shear stress which causes an average of 0.5 inch of soil loss over the entire channel bottom, as reported by the American Association of State Highway and Transportation Officials, National Transportation Product Evaluation Program, Erosion Control Products (AASHTO NTPEP). Temporary products shall at a minimum be tested under unvegetated conditions. Permanent products shall be tested under vegetated conditions.

NOTE 3: The Vegetation Enhancement of an ECP is defined as the percentage of vegetation improvement compared to the control. The Vegetation Enhancement of an ECP shall be measured in accordance with the requirements given in ASTM D 7322 "Determination of Temporary Degradable Rolled Erosion Control Product (RECP) in Encouraging Seed Germination and Plant Growth".

860.12 Fertilizer.

(a) General.

The fertilizer or fertilizers used shall be of the type and grade provided herein, on the plans and/or the proposal form and when tested by current methods adopted by the Association of Official Agricultural Chemists, shall comply with Alabama Fertilizer Laws, Title 2, Sections 282-300, Alabama Code of 1940, as amended.

(b) Manure.

Lot or stable manure shall consist of animal droppings which may be mixed with not over 25 percent, by volume, of bedding material and shall be free of materials toxic to plant growth, and reasonably free from refuse. It shall be well rotted and not have lost its strength by leaching or injurious fermentation. It shall not contain an excess amount of water and shall be of such consistency as to mix readily with soil and capable of being broken down or made fine.

(c) Manufactured Fertilizers.

1. Manufactured fertilizer shall be standard commercial products and shall contain not less than the percentages by weight {mass} of the ingredients set out in the following table:

TYPE	Nitrogen N	Phosphorus P_2O_5	Potash K_2O
15-0-15	15		15
13-13-13	13	13	13
10-10-10	10	10	10
8-8-8	8	8	8
0-14-14	0	14	14
4-12-12	4	12	12
4-16-8	4	16	8
Super Phosphate		18.0	
Ammonium Nitrate	33.5		
Ammonium Sulphate	20.5		
Sodium Nitrate	16.0		
Potassium Chloride			60.0

2. An allowance of five percent variation or tolerance of the above proportions will be permitted based on relative commercial value.

3. Nitrogen may be derived from any nitrogen-carrying material approved by the State Commissioner of Agriculture and Industries.

4. Cottonseed meal shall contain 41 percent protein or 6.56 percent nitrogen.

5. All fertilizers shall be transported in containers which will insure proper protection, handling, and which are commonly used with such fertilizers.

6. Fertilizers containing pesticide materials produced by a recognized, responsible manufacturer and prequalified for use by the State Department of Agriculture and Industries or the U.S. Department of Agriculture may be used with the approval of the Engineer.

(d) Agricultural Limestone.

All limestone for agricultural liming purposes shall be crushed or ground to such a degree of fineness that 90 percent of the material will pass through a 10 {2.00 mm} mesh screen and not less than 50 percent of the material will pass through a 60 {250 µm} mesh screen. All such limestone shall also have a neutralizing value of 90 percent calcium carbonate or better.

(e) Basic Slag.

Basic slag shall be ground open hearth basic slag containing not less than the percentage by weight {mass} of the following ingredients.

P_2O_5 (Available) .....2.0 Iron Oxide 20.0
Magnesium Oxide .....6.0 Calcium Oxide 18.0
Manganese Oxide .....2.0 Neutralizing Value 55.0

At least 80 percent shall pass through a 100 {150 µm} mesh screen and at least 90 percent shall pass a 50 {300 µm} mesh screen.

When basic slag is substituted for limestone in seeding, sprigging, and/or solid sod planting operations, the amount applied shall be adjusted to equal the neutralizing effect of the specified amount of limestone as defined in Subarticle 860.12(d). Blends of basic slag and other elements, such

as 0-6-6, 0-5-6 +.05B and 0-4-12 +.05, may be used and the added elements credited to the total element requirements for plant food.

860.13 Water.

Water free from substances harmful to the growth of plantings will be approved as suitable for use with roadway improvement materials.

860.14 Blank.

SECTION 861
GAS PIPE, VALVES, AND APPURTENANCES

861.01 Steel Gas Pipe.

Steel pipe shall meet the requirements of API 5L, ANSI B36.10 and ANSI B36.19. Pipe coating shall meet the requirements of AWWA C-203.

861.02 Steel Fittings and Flanges.

Buttweld fittings shall meet the requirements of ANSI B16.9. Steel fittings and flanges 2 inches {50 mm} and smaller shall meet the requirements of ANSI B16.11. Steel fittings and flanges larger than 2 inches {50 mm} shall meet the requirements of ANSI B16.5. All bolts shall meet the requirements of ASTM A 307 Grade B with semi-finished heavy hex nuts. Fittings shall have a minimum pressure rating equal to the adjoining pipe installed. Fittings shall be coated meeting the requirements of AWWA C-203.

861.03 Flanged Gaskets.

Flanged gaskets shall be compressed material meeting the requirements of ANSI B16.21. Flanged gaskets shall be 1/16 inches {1.5 mm} thick composition type.

861.04 Polyethylene (PE) Plastic Pipe and Fittings.

Pipe and fittings shall be made of PE2406 ASTM D 3350 cell classification 345343C or PE3408 ASTM D 3350 cell classification 345544C. The wall thickness shall be determined by the depth of bury, loading on the pipe, and the pipe's internal pressure.

861.05 Valve.

Valves shall be as described in the project plans and specifications. Valves shall be selected from the Utilities' approved material/manufacturer list.

861.06 Valve Boxes and Stem Extensions.

Valve boxes shall be cast iron with screw or slide-type adjustments and provided with all valves that are installed vertically. Valve boxes shall have a minimum diameter of 5.25 inches {133 mm}. Box covers shall be marked "gas". Valve boxes shall be selected from Utilities' approved material/manufacturer list. Valve stem extensions (including lubrication fitting) shall be provided with all valves that are greater than 3 feet {0.9 m} below the adjacent ground surface. The extension stem shall be of the same size as the valve stem and shall be provided with a stem guide.

861.07 Tapping Valve.

Tapping valves shall be as described in the project plans and specifications. Where required the tapping valve shall include a sleeve to hold the valve in place. Tapping valves and sleeves shall be selected from the Utilities' approved material/manufacturer list.

SECTION 862
UTILITY ENCASEMENT PIPE

862.01 Welded Steel Encasement Pipe.

Welded steel encasement pipe shall comply with the appropriate requirements for the size shown in the following table unless local codes or ordinances are more stringent:

Pipe Diameter inches {mm}	Minimum Wall Thickness inches {mm}	Pipe Requirements
< 4 {101.6}	Sch. 40	ASTM A 53, Grade B
4 – 12{101.6 – 304.8}	0.188 {4.78}	ASTM A 252, Grade 2
>12 – 24 {>304.8 – 609.6}	0.250 {6.35}	ASTM A 252, Grade 2
>24 {609.6}	0.375 {9.525}	ASTM A 252, Grade 2

All pipe shall be coated inside and out with at least one shop coat of an approved primer paint. In addition, the external surface shall be treated with one coat of asphaltum paint, meeting the requirements of Federal Specification TT-C-494B Type II, Composition G. Fusion-Bonded Epoxy Coating, meeting the requirements of AWWA C213, may be used as an alternative to the shop coat primer and asphaltum paint. Other approved protection material may be used with prior approval by the Department. Hydrostatic pressure test is not required for this pipe.

862.02 Encasement Spacers.

Spacers shall be stainless steel or as approved by the Engineer. The spacer shall be sized for the carrier pipe and encasement pipe used.

862.03 Encasement End Seals.

Encasement end seals shall be synthetic rubber with a stainless steel zipper or closer. The seal shall be secured to the encasement with a stainless steel band clip or thumbscrew clip with a polyethylene strip placed under each clip. Proper flexibility between the carrier pipe and the encasement pipe shall be provided.

862.04 Vent Pipes.

Vent pipes shall be 2 inch welded steel meeting the requirements of Section 862.01.

862.05 High Density Polyethylene (HDPE) Pipe.

HDPE pipe and bends 4 inches {101.6 mm} and smaller shall meet the requirements of ASTM D1248, ASTM D 3350 (PE 3408 cell classification 335434C), and ASTM F 714. The HDPE pipe shall have a minimum wall thickness of SDR 11.

SECTION 863
WATER PIPE, FIRE HYDRANTS, VALVES, AND APPURTENANCES

863.01 Ductile Iron Water Pipe.

Ductile Iron pipe shall meet the requirements of AWWA C151 with a minimum working pressure of 150 psi {1030 kPa}. The pipe shall have an inner cement mortar lining meeting AWWA C104 and an outer bituminous coating. The push-on joints shall meet the requirements of AWWA C111. Restrained joints shall meet the requirements of AWWA C110. Lock joint pipe shall meet the requirements of AWWA C151. The pipe length shall be a minimum of 18 feet {5.5 m}.

863.02 Ductile Iron Fittings.

Ductile Iron fittings shall meet the requirements of AWWA C110, AWWA C153, or AWWA C151 when approved by the Engineer. Fittings shall have an inner cement mortar lining meeting AWWA C104 and an outer bituminous coating. Fittings shall have a minimum pressure rating equal to the adjoining pipe installed. For fittings sizes 4 inch {100 mm} through 12 inch {300 mm}, the minimum pressure rating shall be 250 psi {1720 kPa}.

863.03 Copper Water Pipe.

Pipe and fittings shall meet the requirements of ASTM B88 Type K.

863.04 Poly (Vinyl Chloride) (PVC) Plastic Pipe.

Pipe sizes 4 inch {100 mm} to 12 inch {300 mm} shall meet the requirements of AWWA C900 Class 235, DR 18 or heavier. Pipe sizes 14 inch {350 mm} to 48 inch {1200 mm} shall meet the requirements of AWWA C905 Pressure Class 235, DR 18 or heavier. Pipe and fittings sizes smaller than 4 inch {100 mm} shall meet

the requirements of PVC 1120, PVC 1220, or PVC 2120 with a minimum cell classification 12454-B for ASTM D2241, SDR 26 or heavier or ASTM 1785 Schedule 40, 80, or 120.

Joints and gasket material shall be as recommended by the pipe manufacturer. Solvent welding of field joints shall only be allowed for pipes 1.5 inches {38 mm} in diameter and smaller.

863.05 Polyethylene (PE) Tubing.

Pipe and fittings 2 inches {50 mm} and smaller shall be made of PE3408 meeting the requirements of ASTM D 2239, minimum SIDR 7, ASTM D3350 and AWWA C901.

863.06 High Density Polyethylene(HDPE) Pipe.

HDPE pipe and bends shall meet the requirements of ASTM D1248, ASTM D3350(PE 3408), and ASTM F714. The HDPE pipe shall have a minimum wall thickness determined by the pressure rating required for use.

863.07 Cross-Linked Polyethylene (PEX Type A) Pipe.

Pipe 2 inches {50 mm} and smaller shall meet the requirements of AWWA C 904, Standard Dimension Ratio (SDR) 9, and standard Copper Tube Sizes (CTS). Fittings shall meet the requirements of AWWA C800 and for brass compression sleeve fittings. The pipe shall only be used below ground.

863.08 Gate Valve.

Gate valves shall meet the requirements of AWWA C509. Gate valves shall have o-ring seals. Gate valves shall have a non-rising stem that opens counterclockwise with a 2 inch {50 mm} square nut. Gate valves shall have mechanical joints meeting the requirements of AWWA C-111. The disc shall be SBR coated and the valve body shall be fusion bonded epoxy inside and out. Valves shall be furnished complete with necessary gaskets, bolts, and nuts as needed for mechanical joint ends. Gate valves shall be selected from the Utilities' approved material/manufacturer list.

863.09 Butterfly Valve.

Butterfly valves shall be rubber seated and meet the requirements of AWWA C504. The valve body shall meet the requirements of ASTM A126, Class B or ASTM A48, Class 40. Butterfly valves shall open counterclockwise with a 2 inch {50 mm} square nut. Butterfly valves shall have mechanical joints meeting the requirements of AWWA C-111. The disc shall meet the requirements of ASTM A536 or ASTM A48, Class 40. The rubber mating seat shall be stainless steel. All butterfly valves shall be provided with o-ring seals, nonadjustable stuffing boxes and shall be self-sealing or self-adjusting to allow for replacing without removing the valve or the valve shaft. Butterfly valves shall be selected from the Utilities' approved material/manufacturer list.

863.10 Valve Boxes and Stem Extensions.

Valve boxes shall be cast iron and provided with all valves that are installed vertically. Valve boxes shall have a minimum diameter of 5 1/4 inches{130 mm}. Box covers shall be marked "water". Valve boxes shall be selected from the Utilities' approved material/manufacturer list. Valve stem extensions shall be provided with all valves that are greater than 3 feet {900 mm} below the adjacent ground surface. The extension stem shall be of the same size as the valve stem and shall be provided with a stem guide.

863.11 Tapping Valve & Sleeve.

Tapping valves shall meet the requirements for gate valves as described in section 863.07. Tapping sleeves shall be ductile iron, cement mortar lined meeting the requirements of AWWA C104, and have a bituminous exterior coat.

863.12 Air Release Valve.

Air release valves shall be as detailed by project plans and specifications.

863.13 Corporation Stop and Curb Stop.

Corporation stops shall meet the requirements of AWWA C800. Curb stops shall have full port openings. Corporation stops and curb stops shall have compression type connections and shall be selected from the Utilities' approved material/manufacturer list.

863.14 Fire Hydrant.

Fire hydrants shall meet the requirements of AWWA C502. Fire hydrant shall have a minimum working pressure of 175 psig {1200 kPa} and a minimum test pressure of 300 psig {2070 kPa}. Fire hydrants

shall have two each 2.5 inch {63 mm} nozzles and one each 4.5 inch {114 mm} pumper nozzle. Fire hydrants shall have a 1.5 inch pentagon, one-piece operating nut that opens left. The fire hydrant main valve shall close with pressure. Fire hydrants shall have a 6 inch {150 mm} mechanical joint inlet. All operating parts, including the drain ring, operating nut, hold-down nut, upper valve plate, seat ring, drain lever, and nozzles shall be made of bronze. The bonnet assembly shall provide for an oil or grease reservoir and lubricating system that lubricants all stem threads and bearing surfaces each time the hydrant is operated. The reservoir shall be completely sealed from the waterway and all external contaminants by two each o-ring stem seals. Fire hydrants shall be factory pre-filled with a lubricant suitable for a working temperature range of –60 °F {-51.4 °C} to +150 °F {65.6 °C}. Fire hydrant shall be painted and seal coated as required by the project plans and specifications.

863.15 Flush Hydrant.

Flush Hydrants shall be the type shown on the plans or designated by the Engineer.

863.16 Line Stop.

A line stop to stop the flow of water in a portion of the main without interruption of water service shall be manufactured and installed by either T.D. Williamson, Inc., Severn Trent(Hydra-Stop), IPSCO, or an Engineer approved equal. The line stop and appurtenances shall be pressure rated for a minimum of 150 psi to safely cease the flow of water in the existing water main. The line stop shall be designed for the water main material shown on the plans and field verified prior to installation. The thrust restraint shall be as detailed in the project plans. The Contractor performing the installation of the line stop shall have successful experience in water main tapping and line stopping.

SECTION 864
GUARDRAIL AND BARRIER RAIL MATERIALS

864.01 Rail Elements.

(a) Beam Plate Guardrail.

1. Steel.

Steel rail elements and accessories shall conform to the requirements given in AASHTO M 180.

Zinc coating shall be Type II, 4.00 ounces per square foot {1220 g/m²}, minimum triple spot test.

Chemical composition for Type 4 beams shall conform to one of the following based on ladle analysis.

CHEMICAL COMPOSITION TYPE 4 BEAMS									
Blend	C	Mn	P	S	Si	Cu	Cr	Ni	Zr
No. 1	0-12 Max.	0.20 to 0.50	0.07 to 0.15	0.05 Max.	0.25 to 0.75	0.25 to 0.55	0.30 to 1.25	0.65 Max.	- - -
No. 2	Shall conform to the requirements of ASTM A 606 for Type 4, high strength - low alloy - hot rolled sheet or strip. Members or accessories for beams meeting ASTM A 606 which require welding shall meet the requirements of ASTM A 588 for Grade A or B Material.								

In addition, for Type 4 beams after fabrication, all steel shall be blast cleaned or pickled to remove all mill scale. Blast cleaning shall conform to Steel Structures Painting Council Surface Preparation Specification No. 10 Near-White Metal Blast Cleaning (SSPC-SP10). All pickling acid shall be thoroughly rinsed off. All fabricated steel parts shall be handled with care to avoid gouges, scratches, and dents. The steel shall be kept clean of all foreign material, such as paint, grease, oil, chalk marks, crayon marks, concrete spatter, or other deleterious substances. Natural oxidation of the steel will not be considered foreign material. Storage in transit, in open cars and trucks, for an extended period will not be permitted. Steel parts stored outside in yards or at job-sites shall be positioned to allow free drainage and air circulation.

2. Aluminum.

Aluminum alloy rain element shall be aluminum alloy 2023 T-3 conforming to the requirements of ASTM B 209. The rail shall be of such thickness as will meet strength requirements of AASHTO M 180 for the strength class designated; however, in no case will the tensile strength of the full size

beam (including a splice at the center) be less than 80,000 pounds {355 kN} for Class A or 100,000 pounds {445 kN} for Class B. The shape shall meet AASHTO M 180 requirements.

(b) Barrier Rail.

The barrier rail elements, including all accessories, shall conform to the material requirements shown on the plans for the type material of which the barrier rail is to be constructed.

864.02 Posts.

(a) Treated Timber Posts.

Timber posts shall be sawed to within plus or minus 1 inch {25 mm} of the length and plus or minus 3/8 of an inch {10 mm} of the full end dimensions shown on the plans. Timber block-outs shall be sawed to within 1/4 of an inch {6 mm} of the length and plus or minus 3/8 of an inch {10 mm} of the full end dimensions shown on the plans. Holes shall be drilled slightly smaller than the designated bolt size so as to provide a driving fit.

All timber shall be Southern Yellow pine, Grade No. 1SR or better, in accordance with the Southern Yellow Pine Inspection Bureau's grading system. Post and blockout treatment shall be in accordance with AWPA-U-1 as applicable to guardrail posts. The preservative shall be one recommended under AWPA-U-1 except that within a contract only one type will be permitted unless otherwise permitted in writing by the Engineer. All timber posts and blockouts should be fabricated and holes drilled before treatment, but where field modifications of necessity are made after treatment, the new surfaces shall be given a preservative treatment in accordance with the provisions of AWPA-M-4 using a method approved by the Engineer.

(b) Metal Posts.

Steel posts, including block-outs for guardrail, shall comply with the requirements of ASTM A 36, modified to waive the maximum tensile strength. All material shall be new and of the size, shape, etc. noted by the plan details, hot-dip galvanized after fabrication.

Metal posts for barrier rails shall be steel meeting the requirements noted in paragraph one above or when aluminum barrier rail is used, aluminum posts conforming to the requirements of ASTM B 221, Alloy 6351-T4 or 6061-T4 of the size, shape, etc. noted by plan details.

864.03 Anchors.

Concrete for anchors shall be constructed of Class A concrete in conformity with the requirements given in Section 501. All surfaces shall be given a Class 1 finish with all exposed surface given a Class 2 surface finish.

Metal parts used in anchors shall comply with the appropriate requirements for metals noted elsewhere in this Section or other portions of these Specifications.

Wire rope (cable) for anchors shall be 3/4 inch {19 mm} nominal diameter meeting the requirements of AASHTO M 30, Type II, having a Class A galvanization coating.

864.04 Galvanization.

All metal required by the plans or specifications to be galvanized shall be galvanized after fabrication in accordance with AASHTO M 111 amended to cover the weight {mass} of the zinc coating specified in Article 864.01. Shop fabrication shall be considered to include all work necessary to prepare the unit for immediate and complete installation. No punching, cutting, burning, or welding will be permitted in the field except for special details in exceptional cases as may be directed by the Engineer; however, in such cases, holes shall be drilled and cutting done by sawing and the area treated as provided in Subarticle 630.03(c).

SECTION 870
ADHESIVES

870.01 Description.

This Section shall cover the requirements for adhesives used in the following phases of highway construction.

870.02 Adhesives For Pavement Markers.

(a) Permanent Marker Adhesive.

Adhesives furnished for use to affix permanent pavement markers to the pavement shall be listed on List V-2, PERMANENT PAVEMENT MARKERS, MARKER ADHESIVE, DELINEATORS AND HAZARD MARKERS, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

(b) Temporary Marker Adhesive.

Adhesives furnished to affix temporary markers to the pavement shall be any suitable type of adhesive for the intended purpose, except that in those locations where the markers will be required to be removed, the adhesive shall be a type that will allow for the complete removal of the marker without scarring or disfiguring the pavement.

870.03 Epoxy Adhesives for Bonding Concrete to Concrete and Concrete to Other Materials.

Epoxy adhesive furnished for use in bonding concrete and other materials (except pavement markers) shall meet the appropriate requirements of AASHTO M 235 for the type of work for which the adhesive is to be used. The "Volatile Content, Cured System" requirement of AASHTO M 235 shall be waived.

The Type, Grade, and Class of the epoxy adhesive to be used in the work will be shown by plan details, by these specifications, or as ordered by the Engineer.

Adhesives furnished for use shall be listed on List II-7, EPOXIES FOR USE WITH PORTLAND CEMENT CONCRETE, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

870.04 Adhesives for Concrete Anchoring Systems.

Adhesives furnished for use to anchor tie bars in concrete or other concrete anchoring systems shall be listed on List II-15, CONCRETE ANCHORING SYSTEMS, of the Department's "Materials, Sources, and Devices With Special Acceptance Requirements" Manual. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

SECTION 871
FENCING MATERIALS

871.01 Chain Link Fence.

Materials for chain link fence unless specified otherwise on the plans shall conform to the following:

(a) Fabric.

Fence fabric shall meet the requirements of AASHTO M 181 using 2 inch uniform square mesh made from 0.148 inch (9 gage) {3.75 mm} wire with either a Type I, Class D (zinc coated steel); or Type II (Aluminum coated steel) finish. When a polyvinyl chloride coating is specified either a Class A or a Class B coating will be acceptable.

(b) Supports.

Supports shall meet the requirements of AASHTO M 181 and be either metallic coated steel Grade 1 or Grade 2, or Aluminum. Minimum sizes and weights of posts, rails and framing for all steel elements shall be as follows:

Steel Fence Supports & Framing	
Line Post 3-6 ft. {1 - 2 m} high fence	1.90" O.D. Grade 1 Pipe @ 2.72 #/ft. {48 mm O.D. Grade 1 Pipe @ 4.05 kg/m}
	1.90" O.D. Grade 2 Pipe @ 2.28#/ft. {48 mm O.D. Grade 2 Pipe @ 3.39 kg/m}
	1.875" x 1.625" x .105" "C" Section @ 1.85 #/ft. {47 mm x 41 mm x 2.5 mm "C" Section @ 2.75 kg/m}
Line Post 7-12 ft. {2.1 - 4 m} high fence	2.375" O.D. Grade 1 Pipe @ 3.65 #/ft. {60 mm O.D. Grade 1 Pipe @ 5.43 kg/m}
	2.375" O.D. Grade 2 Pipe @ 3.12 #/ft. {60 mm O.D. Grade 2 Pipe @ 4.64 kg/m}
	2.25" x 1.70" x .121" "C" Section @ 2.64 #/ft. {57 mm x 43 mm x 3 mm "C" Section @ 3.93 kg/m}
	2.25" x 1.70" x .143" "H" Section @ 3.26 #/ft. {57 mm x 43 mm x 3.5 mm "H" Section @ 4.85 kg/m}
Corner & Pull Posts 3-6 ft. {1 - 2 m} high fence	2.375" O.D. Grade 1 Pipe @ 3.65 #/ft. {60 mm O.D. Grade 1 Pipe @ 5.43 kg/m}
	2.375" O.D. Grade 2 Pipe @ 3.12 #/ft. {60 mm O.D. Grade 2 Pipe @ 4.64 kg/m}
	2.5" x 2.5" Sq. Tubing @ 5.70 #/ft. {63 mm x 63 mm Sq. Tubing @ 8.48 kg/m}
Corner & Pull Posts 7-12 ft. {2.1 - 4 m} high fence	2.875" O.D. Grade 1 Pipe @ 5.79 #/ft. 73 mm O.D. Grade 1 Pipe @ 8.62 kg/m
	2.875" O.D. Grade 2 Pipe @ 4.64 #/ft. {73 mm O.D. Grade 2 Pipe @ 6.90 kg/m}
	3" x 3" Sq. Tubing @ 9.10 #/ft. {75 mm x 75 mm Sq. Tubing @ 13.54 kg/m}
Gate Post for Gate Leaf Width 6 ft. {2 m} and less	2.875" O.D. Grade 1 Pipe @ 5.79 #/ft. {73 mm O.D. Grade 1 Pipe @ 8.62 kg/m}
	2.875" O.D. Grade 2 Pipe @ 4.64 #/ft. {73 mm O.D. Grade 2 Pipe @ 6.90 kg/m}
	2.5" x 2.5" Sq. Tubing @ 5.70 #/ft. {63 mm x 63 mm Sq. Tubing @ 8.48 kg/m}
Gate Post for Gate Leaf Width Over 6 ft. to 13 ft. {2 m to 4 m}	4.0" O.D. Grade 1 Pipe @ 9.11 #/ft. {102 mm O.D. Grade 1 Pipe @ 13.56 kg/m}
	4.0" O.D. Grade 2 Pipe @ 6.56 #/ft. {102 mm O.D. Grade 2 Pipe @ 9.76 kg/m}
Gate Post for Gate Leaf Width Over 13 ft. to 18 ft. {4 m to 6 m}	6.625" O.D. Pipe @ 18.97 #/ft. {168 mm O.D. Pipe @ 28.3 kg/m}
Gate Top & Middle Rail	1.660" O.D. Grade 1Pipe @ 2.27 #/ft. {42 mm O.D. Grade 1 Pipe @ 3.38 kg/m}
	1.660" O.D. Grade 2 Pipe @ 1.84 #/ft. {42 mm O.D. Grade 2 Pipe @ 2.74 kg/m}
Gate Frames	1.660" O.D. Pipe @ 2.27 #/ft, {42 mm O.D. Pipe @ 3.38 kg/m}
	1.660" O.D. Grade 2 Pipe @ 1.84 3/ft. {42 mm O.D. Grade 2 Pipe @ 2.74 kg/m}
	2" x 2" Sq. Tubing @ 3.85 #/ft. {50 mm x 50 mm Sq. Tubing @ 5.73 kg/m}

Tolerances for Steel Tubing and Shapes		
Shape and Size	Dimension	Weight {Mass}
Tubular, to and incl. 1 1/2" {38 mm}	+ 1/64", - 1/32" {+ 0.5 mm, - 1 mm}	± 5%
Tubular, larger than 1 1/2" {38 mm}	± 1%	± 5%
"C" Section, to and incl. 2.25"x 1.70" {57 mm x 43 mm}	± 0.0625 { ± 1.5 mm}	± 5%
"H" Section, 2.25"x 1.70" {57 mm x 43 mm} & larger	± 0.0937 { ± 2.5 mm}	± 5%

Minimum sizes and weights {masses} of posts, rails and framing for all aluminum elements shall be as follows:

Aluminum Fence Supports & Framing	
Line Post 3-6 ft. {1 - 2 m} high fence	2.375" O.D. Pipe @ 1.25 #/ft. {60 mm O.D. Pipe @ 1.86 kg/m}
	2.25" x 1.95" "H" Section @ 1.25 #/ft. {57 mm x 49 mm "H" Section @ 1.86 kg/m}
Line Post 7-12 ft. {2.1 - 4 m} high fence	2.875" O.D. Pipe @ 2.00 #/ft. {73 mm O.D. Pipe @ 2.98 kg/m}
	2.5" x 2.5" Sq. Tubing @ 1.25 #/ft. {63 mm x 63 mm Sq. Tubing @ 1.86 kg/m}
Corner & Pull Posts 3-6 ft. {1 - 2 m} high fence	3.0" O.D. Pipe @ 2.62 #/ft. {75 mm O.D. Pipe @ 3.90 kg/m}
Corner & Pull Posts 7-12 ft. {2.1 - 4 m} high fence	3.0" O.D. Pipe @ 3.00 #/ft. {75 mm O.D. Pipe @ 4.46 kg/m}
Gate Post for Gate Leaf Width 6 ft. {2 m} and less	3.0" O.D. Pipe @ 2.62 #/ft. {75 mm O.D. Pipe @ 3.90 kg/m}
	3.0" x 3.0" Sq. Tubing @ 2.0 #/ft. {75 mm x 75 mm Sq. Tubing @ 2.98 kg/m}
Gate Post for Gate Leaf Width Over 6 ft. to 13 ft. {2 m to 4 m}	4.0" O.D. Pipe @ 3.0 #/ft. {100 mm O.D. Pipe @ 4.46 kg/m}
Gate Post for Gate Leaf Width Over 13 ft. to 18 ft. {4 m to 6 m}	6.625" O.D. Pipe @ 7.0 #/ft. {168 mm O.D. Pipe @ 10.42 kg/m}
Gate Top & Middle Rail	1.660" O.D. Pipe @ 0.786 #/ft. {42 mm O.D. Pipe @ 1.17 kg/m}
Gate Frames	1.660" O.D. Pipe @ 0.786 #/ft. 42 mm O.D. Pipe @ 1.17 kg/m
	1.5" x 1.5" Sq. Tubing @ 0.684 #/ft. {38 mm x 38 mm Sq. Tubing @ 1.02 kg/m}

(c) Hardware and Fittings.

Hardware and fittings shall meet the requirements of AASHTO M 181 and be either metallic coated steel or aluminum.

(d) Miscellaneous Wire.

Tension wire shall be metallic coated steel or aluminum as per AASHTO M 181. Wire used for tying shall be either No. 11 gage {3 mm} metallic coated steel or aluminum.

871.02 Woven Wire Fence.

Materials for woven wire fence unless specified otherwise on the plans shall conform to the following:

(a) Fabric.

Fence fabric shall meet the requirements of ASTM A 116, Zinc Coated Steel Woven Wire Fabric, 1047-6-9, Grade 60, Class 3, or ASTM A 584, Aluminum Coated Steel Woven Wire Fabric, 1047-6-9.

When so designated on the plans for replacement of farm fencing, or fencing placed as a right-of-way consideration, etc., the Contractor may at his option use fabric as listed above or zinc coated steel wire, ASTM A 116, 1047-6-12 ½, Class 1 coating unless otherwise noted on the plans.

(b) Supports and Framing.

Supports for woven wire fence shall be either wood or steel as noted on plan details and if not specified either may be used. Support requirements are as follows:

1. Steel.

Steel supports shall meet the requirements of either AASHTO M 181, metallic coated steel posts, rails, or gate frames, Grade 1 or Grade 2, or posts meeting AASHTO M 281, 8 feet {2.4 m} long, galvanized to AASHTO M 111, with anchor plates.

When so designated on the plans for replacement of farm fencing, or fencing placed as a right-of-way consideration, etc., the Contractor may at his option use posts as listed above or painted steel posts meeting AASHTO M 281, unless otherwise noted on the plans.

Minimum sizes and weights of posts, braces and framing for all steel elements shall be as follows:

Steel Fence Supports & Framing	
Line Post	1.90" O.D. Grade 1 Pipe @ 2.72 #/ft. {48 mm O.D. Grade 1 Pipe @ 4.05 kg/m}
	1.90" O.D. Grade 2 Pipe @ 2.28 #/ft. {48 mm O.D. Grade 2 Pipe @ 3.39 kg/m}
	1.875" x 1.625" x .105" "C" Section @ 1.85 #/ft. {47 mm x 41 mm x 2 mm "C" Section @ 2.75 kg/m}
	Studded “T” Post with Spade Plate @ 11.3 #/post {Studded “T” Post with Spade Plate @ 5.1 kg/post}
Corner, End & Pull Posts	2.375" O.D. Grade 1 Pipe @ 3.65 #/ft. {60 mm O.D. Grade 1 Pipe @ 5.43 kg/m}
	2.375" O.D. Grade 2 Pipe @ 3.12 #/ft. {60 mm O.D. Grade 2 Pipe @ 4.64 kg/m}
Brace Posts	1.660" O.D. Grade 1 Pipe @ 2.27 #/ft. {42 mm O.D. Grade 1 Pipe @ 3.38 kg/m}
	1.660" O.D. Grade 2 Pipe @ 1.84 #/ft. {42 mm O.D. Grade 2 Pipe @ 2.74 kg/m}
Gate Post, Hinge Side	4.0" O.D. Grade 1 Pipe @ 9.11 #/ft. {102 mm O.D. Grade 1 Pipe @ 13.56 kg/m}
	4.0" O.D. Grade 2 Pipe @ 6.56 #/ft. {102 mm O.D. Grade 2 Pipe @ 9.76 kg/m}
Gate Post, Latch Side	2.375" O.D. Grade 1 Pipe @ 3.65 #/ft. {60 mm O.D. Grade 1 Pipe @ 5.43 kg/m}
	2.375" O.D. Grade 2 Pipe @ 3.12 #/ft. {60 mm O.D. Grade 2 Pipe @ 4.64 kg/m}
Gate Frames	1.90" O.D. Grade 1 Pipe @ 2.72 #/ft. {48 mm O.D. Grade 1 Pipe @ 4.05 kg/m}
	1.90" O.D. Grade 2 Pipe @ 2.28 #/ft. {48 mm O.D. Grade 2 Pipe @ 3.39 kg/m}

Tolerances in dimensions and weight shall be the same as specified in Subarticle 871.01(b). Weight tolerance for "T" posts shall be ± 5%.

2. Wood.

Wood supports shall meet the requirements noted herein except as modified by details shown on the plans. Posts shall be sound and free from decay, other defects, or loose knots. Posts may be round or square sawed meeting the applicable requirements of Section 833. The slope of the grain in sawed posts shall not exceed one in ten. All posts shall be reasonably straight. Round posts shall be free of multiple crooks and in no case will posts, where the geometric center lies more than 1 inch {25 mm} outside of a straight line drawn from the center of the post at the butt end, less the burying depth to the center of the tip end, be acceptable. Square sawn posts shall not have crooks in excess of 1 inch

in 5 feet {25 mm in 1.5 m}. The length and sizes of wood posts shall be as detailed on the plans within the following tolerances.

When so designated on the plans for replacement of farm fencing, the Contractor may at his option use posts as listed above or wood posts purchased from local dealers, unless otherwise noted on the plans.

a. Round Posts.

The furnished posts may include posts from the minimum diameter specified up to, but not to include, those 1 inch {25 mm} or larger than the minimum diameter designated. When tapered posts are furnished, the diameter at the butt end should not be more than one and one-half inches larger than the diameter measured at the tip end.

b. Sawed Posts.

The furnished posts shall be of the dimensions shown on the plans, plus 1/2 inch { 12 mm} or minus 1/4 inch {6 mm}.

c. Lengths.

The furnished posts shall not measure over one inch less than specified on the plans. Lengths greater than those shown on plans may be acceptable at the discretion of the Engineer, if not detrimental to the appearance of the fence.

All posts shall be pressure treated in accordance with the provisions of Section 833. All job cuts shall be painted with three coats of hot preservative composed of 60 percent Creosote Oil and 40 percent roofing pitch.

The Contractor shall have the choice of selecting one of the types of treated timber posts shown on the plans. Once a choice is made and erection begun, the Contractor will not be permitted to change to another type without the written permission of the Engineer.

(c) Fasteners.

Fasteners for attaching fencing fabric and wire to wooden posts shall be staples formed from 0.148 inch (9 gage) {3.75 mm} diameter galvanized wire, approximately 1.5 inches {38 mm} long. Fasteners for attaching wire to steel posts shall be as designated in Subarticle 871.01(d).

871.03 Barbed Wire Fence.

Materials for Barbed Wire Fence shall be as follows, except as modified by plan details:

(a) Barbed Wire.

Barbed wire shall meet the requirements of AASHTO M 280 with a Class 3 galvanized coating, or Aluminum coated steel barbed wire, Type I (Standard), ASTM A 585.

When so designated on the plans for replacement of farm fencing, or fencing placed as a right-of-way consideration, etc., the Contractor may at his option use wire as listed above or substitute wire meeting AASHTO M 280, with a Class 1 coating unless otherwise noted on the plans.

(b) Supports and Framing.

Supports and framing shall meet the requirements of Item 871.02(b)2.

(c) Fasteners.

Fasteners shall meet the requirements of Subarticle 871.02(c).

871.04 Gates.

Gates, where required, shall be swing-gates as detailed or specified on the plans. The gate frames shall be the height of the top of the posts and covered with the same wire and fabric used on the fence. The frames shall be formed from tubular shapes meeting the requirements noted in Subarticle 871.01(b) complying with plan details, with all joints welded, or otherwise constructed, to form a rigid unit.

Gates for woven wire fencing of another acceptable design may be permitted provided that the gates are so constructed that they will not sag and the design has been approved in writing.

All gates shall be furnished complete with approved (tamper-proof) hinges, latches, auxiliary braces, and all other necessary fittings, including a heavy padlock with two keys and one master key for each gate furnished.

871.05 Concrete For Setting Posts.

Concrete for setting posts, etc., shall be Class A concrete complying with applicable portions of Section 501, with the following modifications.

The concrete may be dry batched at a central mixing plant and delivered to the project. Before the concrete is placed water shall be added. This may be done in small amounts as needed and mixed on a

mixing board or mortar box. After water is added, the mix shall be used within sixty (60) minutes. Posts, braces and brace struts shall be held in proper position until the concrete hardens. The concrete for all corner, brace and line posts shall have cured for 72 hours before any strain is placed on them.

SECTION 880
SIGN MATERIALS

880.01 Sign Panels.

(a) Aluminum Sign Materials.

1. General.

Aluminum sign materials shall conform to the details and thickness's shown on the plans and the following:

The materials used, unless otherwise noted by plan details, shall meet the requirements noted below and, in addition, the material used shall be free from corrosion, white rust, water stains, dirt, and grease with the panels processed as noted in Item 2 below.

ALUMINUM SIGN MATERIALS	
USE	ALLOY & TEMPER DESIGNATION
Sign Panels	ASTM B 209 Alloy 5052-H38 or 6061-T6
Extruded Shapes (sign panels), Bars or Rods	ASTM B 221 Alloy 6063 – T6
Angles, Structural Shapes (including Stiffeners)	ASTM B 308 Alloy 6061-T6
*Bolts	ASTM B 211 Alloy 2024-T4
Tamper Proof Nuts ≤ ¼"	ASTM B 211 Alloy 2024 – T4
*Spring Lock Washers	ASTM B 211 Alloy 7075-T6
Washers	ASTM B 209 Alloy Alclad 2024 – T4
Rivets	ASTM B 316 Alloy 6053 – T6
Shims	ASTM B 209 Alloy 1100-0
Flange Splicing Material	ASTM B 209 Alloy 6061 – T6
Weld Filler Wire	ASTM B 285 Alloy ER 5356 or ER 5556
*Hex. Nuts (Plain)	ASTM B 211 Alloy 6262-T9
*Hex. Lock Nuts	ASTM B 211 Alloy 2017-T4
* Unless otherwise specified	

Aluminum bolts, nuts, and washers shall have an anodic coating of at least 0.0002 inch {0.0051 mm} in thickness and shall be chromate sealed.

Galvanized bolts, nuts, and washers as specified under Galvanized Signs, or stainless steel hardware meeting the requirements of ASTM F 593, will be acceptable in lieu of the above.

2. Special Treatment of Aluminum Sign Material.

Each panel shall receive a chemical conversion treatment that will produce an acceptable etched surface suitable for either porcelainizing or attachment of reflectorized or non-reflectorized sheeting.

3. Tests and Samples.

The Contractor shall furnish certified test reports confirming compliance with the requirements noted and, in addition, shall furnish samples of all materials used in the signs in accordance with current Departmental policy for evaluation and verification tests.

4. Recycled Aluminum Sign Panels.

Recycled aluminum sign panels will be allowed for installation in accordance with the following requirements.

Recycled sign panels shall be the same alloy and temper required for new sign panels. They shall be free of corrosion and white rust and shall meet the required tolerances for flatness and thickness for new sign panels. The process for removing the old reflectorized or non-reflectorized sheeting shall not damage the chromate coating. Smelting, sanding, and chemical stripping processes for recycling will not be allowed.

Recycled signs will be inspected, sampled, and tested in accordance with current Departmental policy, except certified test reports will not be required. The Contractor shall furnish a materials guaranty that the materials conform to the requirements for recycling the sign panels.

(b) Metal and Galvanization Requirements.

1. Metal and Galvanization Requirements.

Galvanized steel sign sheets shall conform to the details and thickness designated on the plans and the following:

The materials used for Galvanized Steel Signs, unless otherwise noted by plan details, shall meet the following specifications:

USE	ASTM For METAL	ASTM For GALVANIZING
Sign Panels	A 653/A 653M, SS: Grade 33 and A 924/ A 924M	A 123
Angles (including Stiffeners)	A 36	A 123
Bolts, Nuts and Washers, unless otherwise specified.	A 307 *	A 153
* Aluminum bolts, nuts, and washers as specified under Aluminum Signs, or stainless steel hardware meeting the requirements of ASTM F 593, will be acceptable in lieu of.		

Galvanized steel sheets and parts other than bolts, nuts and washers shall be mill galvanized with a 2 ounce per square foot {57 g per 0.1 m^2} coating in accordance with ASTM A 653/A 653M G235. The galvanizing shall be a continuous coat, extra smooth, minimum spangle process. After galvanizing, the sheets are to be given a light, tight, crystalline phosphate coating.

No galvanizing of any steel part may be done until all welding, cutting, milling, punching, and drilling of the part has been completed. This includes all holes necessary for attaching demountable copy.

2. Tests and Samples.

The Contractor shall furnish certified test reports confirming compliance with the requirements noted and in addition shall furnish samples of all materials used in the signs in accordance with current Departmental policy for evaluation and verification tests.

(c) Aluminum Laminated Panels.

1. General.

Panels shall consist of sheet aluminum laminated to a honeycomb core, sealed completely around the perimeter with an extruded aluminum frame to form a surface of the length, width and depth required. These panels may be used either with sign face sheeting meeting the requirements of Article 880.02 or a porcelain enameled face sheet. These laminated panels shall be fabricated in accordance with these Specifications and to sizes and shapes as shown on the plans. The minimum number of panels shall be used for each sign. Panels shall be mounted horizontally on all signs having widths up to and including 24.0 feet {7.3 m}; panels may be mounted vertically on signs having widths exceeding 24.0 feet {7.3 m}. The span between supports on 1 inch {25 mm} thick panel shall not exceed 9.0 feet {3 m} with overhang not in excess of 3.0 feet {1 m}. The span for a 2.5 inch {62.5 mm} thick panel shall not exceed 14.0 feet {4.4 m} with overhang not in excess of 4.75 feet {1.45 m}.

All metal materials shall meet the requirements of Subarticle 880.01(a) unless otherwise specified in this Subarticle.

2. Panel Face and Backing.

The face sheet shall be fabricated in one piece from a sheet meeting the following requirements:

For porcelainized panels the face sheet shall comply with the requirements of Item 880.01(d)3.

For panels to be covered with sign sheeting the face sheet shall meet the requirements specified for the back sheet.

The back sheet shall be fabricated in one piece from a sheet of 3003 alloy, tempered to provide a minimum tensile strength of 18,000 psi {124 MPa} and a minimum yield strength of 12,000 psi {82 MPa} and otherwise meeting the requirements of ASTM B 209. Sheets shall not be less than 0.04 inches {1.02 mm} thick and free from all soil or corrosion prior to lamination.

3. Perimeter Frame.

Each panel section shall be provided with a perimeter frame. Frames shall be fabricated of extruded shapes of #6063-T6 Aluminum, with all joints mitered, and firmly affixed together with the exterior framing sealed against moisture penetration. The horizontal top and bottom frame members shall have an integral retainer track for affixing mounting bolts with an additional slot milled in the frame for field insertion of post clip bolts. If the horizontal finished dimension of the sign exceeds 24 feet {7.3 m} and vertical panels are used, the vertical frame members shall have an integral retainer track for mounting bolts. On the perimeter of the finished sign, a 1/8 inch {3 mm} tolerance from flush between the sheets and frame will be allowed and all edges shall be straight within 1/8 inch {3 mm} from a straight plane. All sharp edges that would present a hazard in handling shall be smoothed.

4. Core Material.

Core material shall be of the appropriate thickness, as required, and shall be phenolic impregnated paper honeycomb. Thickness of core materials shall be held within a tolerance of plus or minus 0.010 inch {0.254 mm}. Core material shall meet Specification MIL-D-5272 for resistance to fungus. Cell size, approximately 1/2 of an inch {13 mm}; weight {mass} of paper, 80 pounds {36 kg}; impregnation, 18 percent by weight {mass} minimum.

a. Laminating Adhesive.

The laminating adhesive shall be a thermoplastic neoprene rubber base solvent type or a thermo-setting type exhibiting a permanent oil and water resistant bond.

b. Tensile Strength.

The tensile strength of the honeycomb type laminated construction shall have a minimum of 20 psi {138 kPa} when tested in accordance with ASTM Designation C 297 and aged in accordance with ASTM Designation C 481, Cycle "B".

5. Flatness.

All adhesively bonded panels shall have an exterior face of such flatness that when measured at normal room temperature of 70 to 80 °F {21 to 27 °C}. The maximum wave slope of the surface at any point, measured from the nominal plane of the surface, shall not exceed 1% for panel to which sign face sheeting is to be attached or 1.5% for panels which have porcelainized face sheets. (Wave slope shall be computed in the following manner: Measure the distance between high points (Dimension A). Place a straight edge across the points and measure the depth of slope (Dimension B). Divide one half of A into B to determine percentage of wave slope.)

6. Seam Closure.

Where multiple panels adjoin, the face and edges shall be milled to a tolerance of plus or minus 1/32 of an inch {0.8 mm} from a straight plane, so that when adjoining panels are assembled, no gap over 1/16 of an inch {1.6 mm} shall be visible between panels. Panels may be milled up to 1/4 of an inch {6 mm} on each side in order to achieve edge uniformity.

Seam closure extrusion between panels shall be as provided by the manufacturer of Type 6063-T6 aluminum. Seam closure extrusion may be set in 3 inches {75 mm} from edge of panels for clearance of rivets and frame.

7. Rivets.

Rivets appearing on the face side of the panel shall be anodized a color similar to that required for the face of the panel. Rivets for mounting letters shall be as specified.

8. Weep Holes.

Weep holes of approximately 1/8 of an inch {3 mm} in diameter shall be drilled in the perimeter frame at the bottom of each panel. Holes are to be spaced approximately 3 inches {75 mm} in from either end and in the center of each panel.

9. Fabrication of Laminated Signs.

Each completed sign face shall comply with the requirements noted in this Section with the legend and border laid out on the sign face in accordance with the approved shop drawing; signs that

do not meet these requirements shall be corrected or removed and replaced in acceptable condition without additional cost to the State.

10. Tests and Samples.

The Contractor shall furnish certified test reports confirming compliance with the requirements noted in this Section in addition to samples of materials used in the manufacturing of the signs in accordance with current Departmental policy for evaluation and verification tests.

(d) Porcelain Enamel Signs.

1. General.

Porcelainized signs may be fabricated from flat aluminum or steel sheets or Aluminum Laminated panels. Materials shall meet the requirements of Subarticles 880.01(a), (b), or (c), unless otherwise modified in this Subarticle.

Porcelain enamel surfaces shall be in accordance with the following requirements. These requirements are basic manufacturing quality controls, and certified test reports will be accepted in lieu of samples. However, samples of each color to be used and for each separate production run shall be furnished for verification of tests of requirements as required by current testing schedule.

a. Coating.

Porcelain enameled signs shall have a base or ground coat, designed to develop minimum adherence, applied to all surfaces which are to be porcelainized. At least one separately fired cover coat, in addition to the base or ground coat, shall be applied to all surfaces being porcelainized.

All porcelain enamel shall conform to the Porcelain Enamel Institute's Specification ALS 105.

The thickness of the enamel coating shall not be less than 0.002 inches {0.051 mm}.

b. Color.

The finish color shall be uniform colors, matching the Alabama Green Chip and the standard interstate colors within the Hue, Value and Chroma ranges of the color Tolerance Charts published by the Federal Highway Administration.

c. Gloss.

The porcelain enamel shall have a gloss reading of 50 to 70 units at an angle of 45° when measured on a photovoltmeter, or a meter capable of giving equal results. (Reference Federal Test Method 6101, and current ASTM Standard Method C 346.)

Panels shall be checked for gloss every 1000 square feet {100 m^2} of production run.

d. Adherence.

Adherence shall be checked by accelerated spall test in accordance with Porcelain Enamel Institute Process Bulletin C-703 AL-1a, (Section 6, Spall Test to Determine Retention of Adherence.)

This test conforms with current ASTM C 703, "Method of Test for Spalling Resistance of Porcelain Enameled Aluminum." Tests shall be performed on process evaluation test specimens, 3 inch x 12 inch {75 mm x 300 mm}, processed with the production run. Test samples shall be processed at a minimum rate of one set of samples per every 1000 square feet {100 m^2} of the production cycle or total order, whichever occurs first, and marked with the date and time of the production run. Extra process evaluation test specimens shall be processed to check any change in processing such as cleaning, enamel formulation, firing, etc. The number of specimens constituting one set of samples shall be three unless otherwise directed by the Engineer.

Failure of any process evaluation test specimen to satisfactorily pass the spall test shall be cause for holding and retesting the 1000 square feet {100 m^2} of the production cycle the specimen represents. For the purpose of retesting, process evaluation test specimens shall be taken from production pieces of the production cycle being held. Failure of any one of the process evaluation test specimens, taken from production pieces, to satisfactorily pass the spall test prescribed by these specifications shall be cause for total rejection of that 1000 square feet {100 m^2} of the production cycle or total order being retested.

e. Acid Resistance.

The porcelain enamel shall have a mass loss of less than 20 mg/square inch {20 mg/645 mm^2} in the boiling 6% citric acid test. Reference test is described in ASTM Standard C 283 "Standard Method of Test for Resistance of Porcelain Enamels to Boiling Acid."

Tests shall be performed on process evaluation test specimens, 3 inch x 12 inch {75 mm x 300 mm}, processed with the production run. Test samples shall be processed at a minimum rate of one set of samples per every 1000 square feet {100 m^2} of the production cycle or total order, whichever occurs first, and marked with the date and time of the production run. Extra process evaluation test

specimens shall be processed without any change in processing such as frits, mill formula, fineness of grind, firing, etc. The number of specimens constituting one set of samples shall be three unless otherwise directed by the Engineer.

Failure of any process evaluation test specimen to satisfactorily pass the acid resistance test shall be cause for holding and retesting the 1000 square feet {100 m^2} of the production cycle the specimen represents. For the purpose of retesting, process evaluation test specimens shall be taken from production pieces of the production cycle being held.

2. Aluminum or Steel Flat or Multiple Flat Panels.

a. Metals.

All materials shall meet the requirements of Subarticles 880.01(a) or (b) unless otherwise specified in this Item.

Aluminum panel sheets shall be an aluminum-alloy or aluminum clad alloy (6061-Core) especially designed for enameling and capable of being porcelain enameled to meet the Specifications noted herein. The aluminum sheets, after enameling, shall have a minimum ultimate strength of 18,000 psi {124 MPa}, a minimum yield strength of 12,000 psi {83 MPa} and an elongation of not less than four percent. If the porcelain enameling process materially alters the temper of the aluminum sheets such that the minimum yield point of the material is below 12,000 psi {83 MPa}, they shall be artificially aged or processed to raise the yield point of the panels to the required minimum stress.

Steel Sheets and Backing Strips shall meet the requirements of ASTM Designation A 424, Type II, and be capable of being porcelain enameled to meet the Specifications noted herein. All steel sheets and backing strips shall be shaped and formed before porcelainization. The exposed surfaces shall be provided with a protective coating of either porcelain or galvanization.

b. Porcelain Coverage.

In addition to the requirements of Item 880.01(d)1, the following shall apply. The base or ground coat may be applied to the entire exposed surface area of the sheets, including face and back. If both sides are covered, the coating thickness's shall be equal and rack marks will be allowed on the back of panels. The face and back shall be of the same color.

c. Flatness.

Each completed sign face, after erection, shall not vary more than 1/8 inch {3 mm} in any 4 foot {1.2 m} length with the maximum variation of 1/4 inch {6 mm} from a flat surface in any 8 foot {2.4 m} length.

3. Porcelainized Aluminum Laminated Panels.

All materials shall meet the requirements of Subarticle 880.01(c) except as noted. Porcelainization of the face sheet shall be as specified in Item 880.01(d)1.

Aluminum Face Sheets shall be an aluminum alloy or aluminum clad alloy (6061-Core) especially designed for enameling and capable of being porcelain enameled to meet the Specifications noted in this Section. The aluminum sheets, after enameling, shall have a minimum ultimate strength of 18,000 psi {124 MPa}, a minimum yield strength of 12,000 psi {83 MPa} and an elongation of not less than four percent. If the porcelain enameling process materially alters the temper of the aluminum sheets such that the minimum yield point of the material is below 12,000 psi {83 MPa}, they shall be artificially aged or processed to raise the yield point of the panels to the required minimum stress.

Face sheets shall not be less than 0.063 inches {1.6 mm} thick after porcelainization.

4. Fabrication of Porcelain Enameled Signs

Each completed sign face shall comply with the surface flatness requirements noted in this Section, with the legend and border laid out on the sign face in accordance with the approved shop drawings; signs that do not meet these requirements shall be corrected or removed and replaced in acceptable condition without additional cost to the State.

5. Tests and Samples.

The Contractor shall furnish certified test reports confirming compliance with the requirements noted in this Section and, in addition, samples of materials used in manufacturing of the signs in accordance with current Departmental policy for evaluation and verification tests, but in no case less than one 3 inch x 12 inch {75 mm x 300 mm} sample of each color used shall be furnished for each separate production run of the porcelain enameled panels.

Verification of the porcelain colors by comparison with the Alabama Green Chip and the Color Tolerance Charts published by the FHWA shall be made on all samples. Noticeable variation of color

in a production run shall be cause of ordering inspection of all sign faces and the rejection of any sign face outside of the tolerances provided by the Color Charts.

(e) Aluminum Louvered Panels.

1. General.

Aluminum louvered sign panels shall consist of aerodynamically designed louvers assembled into a sign panel which is self-supporting, internally braced, and capable of withstanding the wind loading indicated by plan requirements. The complete design assembly shall provide for an efficient flow of air in a horizontal direction with at least 50percent reduction in wind loading, normal to sign face, than that of a solid sign panel of the same size and yet display a solid opaque background when viewed from an angle of 10° or less below the horizontal line of sight.

Louvers shall be of such dimensions as to help maintain the panel rigidly and provided with sufficient internal support and bracing to support and retain the stacked louvers along with preventing aeolian vibrations.

The front face of the sign panel shall have provisions for affixing standard demountable copy (borders and legends) in a firm, rigid manner. The back face of the sign panel shall have provisions for attachment of the panel to the Department's standard supports (ground or overhead).

The Contractor shall obtain Departmental approval of the panel design he proposes to furnish under this specification before such will be allowed on the project. To obtain approval, drawings of the proposed design, along with any necessary supporting data to verify the design, must be submitted.

2. Materials.

Aluminum shall meet the requirements of Subarticle 880.01(a) and the following:

USE	ALLOY AND TEMPER DESIGNATION
Louvers	ASTM B 221 Alloy 6061-T6
Miscellaneous Parts	ASTM B 209 Alloy 6061-T6
Castings	ASTM B 85 Alloy SC84B

All exposed parts of the sign panel shall have a baked enamel finish consisting of primer coat and at least two finish coats providing not less than a 1.5 mil {0.338 mm} coverage. The enamel shall be made of first class materials providing colors within the color tolerance charts published by the FHWA except that the highway green shall be the same shade, etc., as used on the Department's "Porcelain enameled" sign (a color sample will be made available upon request).

3. Fabrication of Sign Panels.

a. Each completed sign face shall be assembled in accordance with the approved design and accepted shop drawings and shall, after erection, provide a rigid panel firmly attached to the sign supports. Sign panels not meeting these requirements shall be corrected or removed and replaced in acceptable condition without additional cost to the State.

b. The legend and border shall be laid out on the sign face in accordance with the contract plans. Spacing and layout of legend and border shall be approved by the Engineer before affixing of the legend and borders to the sign face.

4. Tests and Samples.

The Contractor shall furnish certified test reports confirming compliance with the requirements noted in this Subarticle and, in addition, samples of materials used in the manufacturing of the signs in accordance with current Departmental policy for evaluation and verification tests, but in no case less than one 3 inch x 12 inch { 75 mm x 300 mm} sample of each color used, shall be furnished.

Verification of color by comparison with Color Tolerance Charts, etc. as noted in Item 2 above will be made on all samples. Noticeable variation of color in a panel shall be cause for ordering inspection of all signs and the rejection of any sign face outside the tolerances provided by the Color Charts.

All signs shall be inspected for faulty application, blemishes, or other faults that might impair the serviceability of the sign. Any noticeable color mis-matching, when viewed from a distance of 25 feet {7.6 m} under both daylight or nighttime conditions, shall be cause for rejection of the sign face.

880.02 Reflective and Non-Reflective Sheeting.

(a) General.

Retroreflective sheeting used in the fabrication of sign faces shall meet the requirements for ASTM D 4956. All retroreflective sheeting shall be the ASTM Type classification shown on the ALDOT Standard Highway Drawings for Standard Highway Signs, unless otherwise required by plan details or the proposal.

Non-retroreflective sheeting, Type I-N, shall be a smooth, flat durable gloss plastic film meeting the requirements of ASTM D 4956, Type I, with the Specific Intensity requirements waived.

Sheeting will be classified by type in accordance with the following:

TYPES AND DESCRIPTIONS OF SIGN SHEETING MATERIALS	
Type I	A medium-intensity retroreflective sheeting referred to as "engineering grade" and typically enclosed lens glass-bead sheeting. Typical applications for this material are permanent highway signing, temporary traffic control devices, and delineators.
Type I-N	Non-reflective sheeting
Type II	A medium-high-intensity retroreflective sheeting sometimes referred to as "super engineering grade" and typically enclosed lens glass-bead sheeting. Typical applications for this material are permanent highway signing, temporary traffic control devices, and delineators.
Type III	A high-intensity retroreflective sheeting, that is typically encapsulated glass-bead retroreflective material. Typical applications for this material are permanent highway signing, temporary traffic control devices, and delineators.
Type IV	A high-intensity retroreflective sheeting. This sheeting is typically an unmetallized microprismatic retroreflective element material. Typical applications for this material are permanent highway signing, temporary traffic control devices, and delineators.
Type V	A super-high-intensity retroreflective sheeting. This sheeting is typically a metallized microprismatic retroreflective element material. This sheeting is typically used for delineators.
Type VI	An elastomeric high-intensity retroreflective sheeting without adhesive. This sheeting is typically a vinyl microprismatic retroreflective material. This sheeting is typically used for orange temporary roll-up warning signs, traffic cone collars, and post bands.
Type VII	Sheeting previously classified as Type VII has been reclassified as Type VIII. The designation of Type VII has been discontinued. (ASTM D 4956-09)
Type VIII	A super-high-intensity retroreflective sheeting (ASTM D 4956 Table 2). This sheeting is typically unmetallized, microprismatic with the highest values of retroflection attained at long and medium roadway distances. Typical applications are temporary traffic control devices, delineators, and permanent highway signing.
Type IX	A very-high-intensity retroreflective sheeting which is typically unmetallized, microprismatic with the highest values attained at short roadway distances where viewing angles may be critical. Typical applications are permanent highway signing, temporary traffic control devices and delineators.
Type X	Sheeting previously classified as Type X has been reclassified as Type VIII. The designation of Type X has been discontinued. (ASTM D 4956-09)
Type XI	A super-high-intensity unmetalized cube corner microprismatic sheeting (ASTM D 4956, Table 10). Typical applications are temporary traffic control devices, delineators, and permanent highway signing.

(b) Tests and Samples.

The Department's Product Evaluation Board has established a list of sheetings (V-1, "Materials, Sources, and Devices with Special Acceptance Requirements", manual). Only the materials on this list shall be furnished for use. Refer to Subarticle 106.01(f) and ALDOT-355 "General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements" for further information.

In addition these materials will be inspected, sampled, and tested in accordance with the Department's Testing Manual and Laboratory Manual.

(c) Application of Sheeting.

Application of sheeting shall be in accordance with the manufacturer's recommendations; splicing of sheeting will be allowed on sign faces provided such splices have a minimum overlap of 1/2 inch {13

mm} and are held to a minimum. More than one splice per 48 square feet {4.5 m^2} of panel is considered excessive.

On signs which consist of one panel only, the sheeting shall extend to the edge of the sign panel, except where indicated in the plans. On all signs which are sufficient size to require two or more panels, sheeting shall be applied separately to each panel. No attempt shall be made to extend the sheeting from one panel to adjacent panels. Sheeting shall be applied in strict conformity with the recommendations of the manufacturer.

(d) Color and Luminance Requirements.

The chromaticity and luminance of fluorescent retroreflective materials shall be determined in accordance with the requirements given in ASTM E 991, using instrumentation which complies with the requirements given in E 991 and which has circumferential viewing (Illumination). The instrumentation shall illuminate the specimen with light having the spectral irradiance criteria for ClE Standard llluminant D-65 as set forth in Section 5.1 of E 991 for the testing of fluorescent specimens. The reflectance data for the CIE 1931 2° Observer shall be computed in accordance with ASTM E 308.

Fluorescent retroreflective materials shall meet the requirements for chromaticity coordinates given in the following table.

CHROMATICITY COORDINATES								
Color	1		2		3		4	
	x	y	x	y	x	y	x	y
Fluorescent Orange	0.583	0. 416	0 535	0.400	0.595	0. 351	0. 645	0. 355
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540

Fluorescent retroreflective materials shall meet the luminance requirements given in the following table.

LUMINANCE REQUIREMENTS			
Color	Luminance Factor Limits (Y) (%)		
	Minimum	Maximum	Y_F*
Fluorescent Orange	25	None	15
Fluorescent Yellow	45	None	20
Fluorescent Yellow-Green	60	None	20
*Fluorescent luminance factors (Y_F) are typical values, and are provided for quality assurance purposes only. Y_F shall not be used as a measure of performance during service.			

880.03 Sign Copy.

(a) Applied Copy.

1. General.

Applied copy is classified as copy applied directly to the sign background.

Unless noted otherwise, all standard Class 5, 7 and 10 signs shall have the sign copy applied by either the direct or reverse screening (silk screen) method as noted in Items 2 and 3 below. Route shields and markers with blue background and yellow symbols (typically a Class 4 or a portion of a Class 2 or 6 sign) shall use the Cut-out copy process as noted in Item 5 below . Special Class 5, 7, and 10 signs may utilize cut-out copy or acrylic electronic cuttable film as noted in Item 5 below, if so noted by the plans or on the approved shop drawings.

2. Direct Screening Process.

This method is used for applying non-reflective copy to a sign background.

3. Reverse Screening Process.

This method is used for applying reflectorized copy to a reflectorized background by utilizing transparent inks applied to a white reflectorized background.

4. Screening Material and Application.

Material for application by the silk screen method shall manufacturer recommended matched component inks manufactured especially for use on roadway signs and compatible with the type sign

background material being used. Application of screened copy and curing thereof shall be in strict compliance with the manufacturer's recommendations of the background material.

Colors shall be durable and consistent with the requirements of the FHWA Standards Colors Charts for Signs. The color shall be uniform in acceptable Hue when viewed in daylight and under normal headlights at night.

5. Substitution of Cut-Out Copy or Electronic Cuttable Film for Screen Copy.

Certain signs for which standardization is impractical, such as destination signs, may be authorized to use cut-out copy or acrylic electronic cuttable film unless noted otherwise on the plans.

Cut-out copy shall be fabricated from the appropriate class sheeting by individually cutting the borders, legends, numerals, and symbols, and applying them to the required background in strict compliance with the sheeting manufacturer's recommendation.

If electronic cuttable film is used, it shall be the sheeting manufacturer’s recommended film and shall be applied to the required background in strict compliance with the sheeting manufacturer’s recommendations. The film shall be transparent when used in lieu of reverse screening and non-reflective when used in lieu of direct screening.

When cut out copy or electronic cuttable film is authorized, borders, legends, symbols, or numerals shall be either screened, cut out copy, or created using electronic cuttable film; mixing of methods to form a border, a legend, a symbol, or numerals will not be permitted except when authorized on construction warning signs.

(b) Digital Printing.

An approved digital printing system must be used. Digital printing systems include a digital printer with appropriate software and drivers, flexible white or colored prismatic retroreflective sheeting, acrylic overlay films, and inkjet inks. A list of approved digital printing systems is included in List V-1 of the MSDSAR.

Sign messages shall be printed according to the manufacturer’s recommendations. Digital printing shall produce the desired color and the same retroreflectivity values as required for the reflective sheeting of the same type and color when applied on a reflective sheeting background.

Traffic signs printed with digital ink systems will be fabricated with a full sign Protective Overlay Film designed to protect the entire sign from fading and UV degradation. The overlay will comply with the retroreflective sheeting manufacturer’s recommendations to ensure proper adhesion and transparency.

880.04 Sign Supports.

(a) Ground Mounted Sign Supports.

1. General.

Ground mounted supports shall fall into two categories, a light weight {mass} or bendaway post and a standard or rigid post.

The light weight {mass} or bendaway posts are normally single "U" channels (aluminum or steel) and tubular shapes (round, square, etc.) of such size and design that when hit by a moving vehicle, will easily bendaway from the vehicle without seriously damaging it.

The standard or rigid posts shall be of various designs (shapes, tubular, etc.) which by size and design will not easily bendaway when hit by a moving vehicle. This type post, unless otherwise noted by plan details, will require a "breakaway" feature to be incorporated with the post. The material and design of the breakaway features for the various shapes of standard posts shall be shown by the plan details.

Breakaway features constructed of steel shall have all elements galvanized, unless otherwise provided by the plan details. Damage to galvanization or any bare spots developed during construction shall be treated with two coats of approved galvanizing paint (Section 855) or approved zinc spelter paint. Aluminum elements will require no special treatment, unless so specified by plan details.

All materials furnished for use shall be new, unless otherwise specified by plan details or provisions of the contract.

All tubular post shapes whose design will have a tendency to collect water shall be provided with an approved tight-fitting post cap fabricated of material compatible with that of the post.

2. Steel Posts.

a. Tubular Type (Std.)

This type of post shall be fabricated from standard steel shapes of the size and weight {mass} shown by plan details. Round shapes shall conform to the requirements of ASTM A 53, Grade B,

Schedule 40 or better (no pressure test required). Other shapes and materials shall be as noted by plan details.

b. Beam Type (Std.)

This type of post shall be fabricated from standard beam shapes of the size, shape, and weight {mass} shown on the plans. The material shall conform to the requirements of either ASTM A 588 or A 572, Grade 50, unless otherwise noted by plan details.

c. Light Weight {Mass} or Bendaway Type.

(1) This post shall be fabricated to acceptable shape and design to provide the Moment of Inertia and Section Modulus for the requirements of the designated post size shown by the plan details. The posts shall be made of rerolled rail steel meeting the requirements of ASTM A 499, Grade 60, or a comparable new billet steel meeting the requirements of ASTM A 572, Grade 60. The steel in the posts shall meet the chemical requirements of ASTM A 1 for rails having a nominal weight {mass} of 91 pounds per yard {37 kg/m} or greater. Shaped sections shall be provided with 3/8 inch {9.5 mm} diameter holes placed on 1 inch {25 mm} centers starting 1 inch {25 mm} from the top of the post and extending the full length of the post.

(2) Tubular sections shall be fabricated from steel meeting the requirements of ASTM A 653 SS: GRADE 33 and ASTM A 924/ A 924M. Tubular sections shall be provided with 3/8 inch {9.5 mm} diameter holes placed on 1 inch {25 mm} centers starting 1 inch {25 mm} from the top of the post and extending the full length of the post (holes shall extend through the opposite walls).

In lieu of the above, tubular steel posts may conform to ASTM A 1011/A 1011M SS: Grade 33 or better. The posts shall be provided with 7/16 inch {11 mm} diameter die-cut knockouts on 1 inch {25 mm} centers on all four sides.

d. Post Finish.

Standard posts shall be hot dipped zinc galvanized after fabrication in accordance with ASTM A 123 for beam shape and ASTM A 53 for tubular shape.

Light weight {mass} or bendaway posts shall be zinc galvanized in accordance with the following:

"U" Channel Section - ASTM A 123 after fabrication.

Tubular Section - ASTM A 653, Grade G90 or better. An alternate coating may be an in-line hot dip galvanized zinc coating per ASTM B 6, followed by a chromate conversion coating and cross-linked polyurethane acrylic exterior coating, with the inside surface given a double in-line application of a full zinc-based organic coating.

3. Aluminum Posts.

a. Tubular Type (Std.)

This type of post shall be fabricated from extruded tubing to the size, shape, and wall thickness shown on the plans and shall conform to the Aluminum Association, Alloy 6061-T6 (ASTM B 221).

b. Beam Type (Std.)

This type of aluminum support shall be fabricated from extruded shapes of the size, shape, and weight {mass} shown on the plans and shall conform to the Aluminum Association, Alloy 6061-T6 (ASTM B 308).

c. Light Weight {Mass} or Bendaway Type.

This type of aluminum support shall be fabricated from acceptable extruded shapes meeting the design requirements (Moment of Inertia and Section Modulus) for the designated post size shown in the plan details. Materials shall conform to the requirements of Alloy 6061-T6 of ASTM B 221.

Holes 3/8 inch {9.5 mm} in diameter shall be placed on 1 inch {25 mm} centers starting 1 inch {25 mm} from the post top and extending the full length of the post or within 8 feet {2.4 m} or less of the bottom of the post (holes in tubular sections shall extend through the opposite walls),

d. Finish.

Aluminum supports shall be provided with a smooth non-glare finish.

4. Bolts, Nuts, Washers and Miscellaneous Hardware.

High strength bolts, nuts, and washers shall meet the requirements of Article 836.33. Bolts, nuts, and washers other than high-strength shall meet the requirements of ASTM A 307 for bolts and the appropriate requirements noted in Subarticle 836.33(a) for nuts and washers.

All bolts, nuts, and washers shall be galvanized utilizing zinc in accordance with the provisions of ASTM B695 Class 50. Other miscellaneous hardware shall be galvanized in accordance with ASTM A 153, Class B.

(b) Overhead Sign Supports.

The materials required for overhead sign supports shall be furnished in accordance with the requirements given in Section 891.

880.05 Protection Of Sign Material.

All sign panels shall be protected by packaging after fabrication and during shipment and storage. Packaging and packing shall be adequate to prevent damage to any part of the sign panel, legends, copy, or borders. Before packaging all paint shall be thoroughly dry and all signs free of moisture. Adhesive tapes shall not be used on any sign face. All packaged signs shall be kept entirely dry.

All assembled or partially assembled signs, other than flat sheet signs, shall have sufficient braces securely attached to prevent buckling or warping at all times from after assembly has begun until the signs have been attached to their permanent supports.

880.06 Sampling, Inspection and Testing of Sign Materials.

Sampling and inspection of sign materials will be done in accordance with the requirements given in ALDOT-245, "Procedures for Sampling and Inspection of Roadway Signs and Overhead Sign Structures."

All hardware such as nuts, bolts, washers, angles, channels, etc., sign panels along with the samples of the materials used in the panels and any certified test reports required and sign supports shall be shipped to the project site. Inasmuch as certain tests require actual inspection of all sign panels, the Contractor shall supply at the time of inspection the necessary personnel for uncrating and movement of the panels.

Until test reports are issued on the sign materials, the Contractor will not be permitted to install the sign materials, unless written approval for such has been obtained from the Central Office.

Should any material samples fail or any question arise concerning submitted samples being representative of those on the project, additional samples shall be selected from those on hand at the job site. Failure of resamples shall be cause for rejection of all items of the type involved.

Verification of color by comparison with Color Tolerance Charts published by the FHWA shall be made. Noticeable variation in color shall be cause of ordering inspection of all sign faces and the rejection of any sign face outside the tolerances provided by the Color Charts.

All signs shall be inspected for faulty application, blemishes, or other faults that might impair the serviceability of the sign or any noticeable color mismatching when viewed from a distance of 25 feet {8 m} under both daylight and nighttime conditions shall be cause for rejection of the sign face.

SECTION 881
DELINEATORS AND HAZARD MARKERS

881.01 Standard Delineators.

(a) General.

A delineator shall consist of one or more colorless or colored reflector units mounted as shown on the plans. A reflector unit shall consist of a hermetically sealed acrylic plastic prismatic reflex reflector with a sealed plastic back or housed in an embossed aluminum housing.

(b) Reflector Units.

1. Reflector Lens.

The reflector lens shall be methyl methacrylate meeting the requirements of Federal Specifications L-P-380, Type 1, Class 3 or ASTM D 788, Grade 8 and shall be of clear or colored transparent plastic, with a minimum of 7 square inches {4500 mm^2} of reflective area. The lens shall have a smooth front surface, free from projection or indentation other than a central mounting hole and identification, and a rear surface bearing a prismatic configuration, such as will effect essentially total reflection of light. The manufacturer's trademark shall be molded legibly on the face or back of the reflector unit.

The backing shall be a heat sealable plastic or metallic foil fused to the lens under heat and pressure around the entire perimeter of the lens and the central mounting hole to form a unit permanently sealed against dust, water, and vapor.

2. Reflector Housing.

To retain the acrylic reflector, the delineator shall have a sealed plastic back or aluminum housing conforming to the following:

- The housing shall be a minimum 0.02 inch {0.51 mm} aluminum conforming to ASTM B 209, alloy 1100-TO or alloy 5052-TO, and formed as shown on the plans.
- Delineators shall have either a plastic or metal gromet 3/16 of an inch {5 mm} in diameter.

3. Optical Requirements.

The specific intensity per unit area of each reflector shall be equal to or exceed the following minimum values when tested in accordance with AASHTO M 290. Measurements shall be made with the reflector spinning to obtain an average reading.

Observation Angle	Entrance Angle	Specific Intensity candle power/square inch/foot candle {candelas/lux/m²}			
		Crystal	Amber	Red	Green
0.1°	0°	17.0 {2448}	10.0{1440}	4.0 {576}	4.0 {576}
0.1°	20°	6.5 {936}	4.0 {576}	1.5 {216}	1.5 {216}

4. Seal Requirements.

When tested in accordance with AASHTO M 290, the reflector shall show no evidence of moisture intrusion.

5. Heat Resistance Requirements.

The reflector shall show no signs of deformation or change in shape nor loss of reflective quality when tested in accordance with AASHTO M 290.

6. Prequalification.

All types of reflectors must be evaluated for conformance with the MUTCD requirements as well as the physical requirements listed above prior to use. The Department maintains a list (V-2) of reflectors meeting these requirements in the manual "Materials, Sources, and Devices With Special Acceptance Requirements". Other reflectors may be used upon evaluation and approval of the Department's Product Evaluation Board.

7. Sampling and Testing.

Sampling and testing shall be done in accordance with the Department's Testing Manual.

8. Packaging.

The reflectors shall be supplied in suitable containers which will protect the units from damage during shipment and storage. Containers shall be legibly marked with the name, type, lot, etc. of the contents.

(c) Posts.

The posts shall be of the design and weight {mass} as shown on the plans. Posts shall be straight with no bending, warping, splits, or other defects. Mounting holes shall be punched or drilled on the centerline of the web, as shown on the plans.

Steel Posts shall be manufactured from rerolled rail steel meeting the requirements of ASTM A 499, Grade 60, or a comparable new billet steel. The steel in posts shall meet the chemical requirements of ASTM A 1 for rails having a nominal weight {mass} of 91 pounds per yard {45 kg/m} or greater, modified to require the carbon content to be between 0.67 and 0.89 percent. The posts shall be hot dip galvanized after forming, cutting, punching, or drilling has been completed. Galvanization shall be in accordance with ASTM A 123. Aluminum posts shall be manufactured from aluminum alloy 6063-T6.

Other types of posts may be used upon evaluation and approval of the Department's Product Evaluation Board.

881.02 Reflective Hazard Markers.

(a) General.

A hazard marker may be either a series of reflector units (three or more) mounted on a backup plate or a designated standard or special reflectorized sign panel.

(b) Reflectors.

The reflectors shall comply with the requirements for delineator type reflectors noted in Subarticle 881.01(b), except the metal housing and metal center grommet will not be required.

(c) Backup Plates.

The backup plates for the hazard markers shall be at least 0.064 inch {1.6 mm} thick aluminum sheets. The surface of the marker facing traffic shall be treated with a coating of baked on yellow enamel (Highway yellow). Attachment of the reflectors to the backup plate and of the backup plate to the post or mounting surface shall be in accordance with the details shown on the plans or an approved substitute.

(d) Posts.

Posts used for mounting hazard markers shall be in accordance with the details shown on the plans and the requirements of Subarticle 881.01(c).

(e) Mounting.

Mountings other than on posts shall be in accordance with plan details.

(f) Sampling and Testing.

Sampling and Testing of the reflector units shall be as prescribed in Subarticle 881.02(b).

(g) Standard or Special Sign Panels.

The panel shall comply with the requirements of Section 880 for signs with the legend or marking as required by plan details.

Sign panels shall be sampled and tested as prescribed in Section 880.

SECTION 882
PAVEMENT MARKERS

882.01 General.

(a) Sampling Procedure and Test Requirements.

1. Permanent Markers.

The Department has established LIST V-2, PERMANENT PAVEMENT MARKERS, TEMPORARY PAVEMENT MARKERS, MARKER ADHESIVE, DELINEATORS AND HAZARD MARKERS, of the Department's manual, "Materials, Sources, and Devices With Special Acceptance Requirements", for permanent pavement markers. Only markers on this list shall be furnished for use. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

2. Temporary Markers.

All markers on LIST V-2 may be used as temporary markers. Only markers on this list shall be furnished for use. Refer to Subarticle 106.01(f) and ALDOT-355 concerning these lists.

(b) Packaging.

The markers shall be supplied in suitable containers which will protect the units from damage during shipment and storage. Containers shall be legibly marked with the name and type, etc. of the contents.

882.02 Reflective Markers.

(a) Class "A" Marker.

Class "A" pavement markers shall meet the requirements of ASTM D 4280 with Surface Characteristics: No Designation - Marker with plastic lens surface.

(b) Class "A-H" Marker.

Class "A-H" pavement markers shall meet the requirements of ASTM D 4280 with Surface Characteristics: Designated "H" - Marker with hard, abrasion-resistant lens surface.

882.03 Non-Reflective Markers.

(a) General.

Class B pavement markers shall be formed of heat fixed ceramic base material constructed in such a manner as to form a solid, watertight unit. The markers shall be of the general size and shape shown on the plans with smooth rounded corners. Any change in the curvature shall be gradual. The top and

sides of the marker shall be smooth and free from mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations. The base of the marker shall be flat (deviation from a flat surface shall not exceed 0.05 inch {1.27 mm}) rough textures (comparable to at least that of a fine grade sand paper) and free from gloss or substances which may reduce the markers bond to the adhesive.

(b) Materials.

Ceramic - Heat fired, vitreous, ceramic base and a heat fired, opaque, glazed top surface. The bottom surface shall be unglazed, suitable for cementing to the road surface. The marker may be produced from any suitable combination of intimately mixed clays, shales, talcs, or other inorganic material. The marker shall be thoroughly and evenly matured and free from defects which will affect the appearance and serviceability.

(c) Tests.

1. Color.

   White - Brightness relative to Magnesium Oxide - 80% Minimum.

   Yellow - Brightness relative to Magnesium Oxide - 40% Minimum and match the standard shade within the red and green balances when compared with Color Chip 33538 of Federal Standard No. 595.

2. Water absorption - 2% Max. (ASTM C 373)

3. Hardness - Moh Hardness - 6 Min.

4. Autoclave Test - shall not craze, spall, or peel when subjected to one cycle at 250 psi {1724 kPa} - ASTM C 424.

5. Glaze Thickness – 0.005 inch {0.13 mm} Min.

6. Strength - Markers shall be capable of supporting a load of 1500 pounds {680 kg} applied as follows:

   A marker shall be centered over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be at least 1 inch {25 mm} high, with an internal diameter of approximately 3 inches {75 mm}, and with a minimum thickness of 1/4 inch {6 mm}. Loading shall be slowly applied to the top of the marker through a 1 inch {25 mm} diameter by 1 inch {25 mm} high metal plug centered on the top of the marker.

   An average compressive strength of three markers shall be obtained; however, any individual marker which fails under a compressive load of less than 1200 pounds {500 kg} shall be cause for rejection of the marker lot being tested.

7. Adhesive Bond Strength -

   The adhesive tensile bond strength to the bottom of the marker accepted for use on the project and the epoxy adhesive accepted for use on the project shall be not less than 1500 psi {10 MPa}.

882.04 Adhesives For Pavement Markers.

Bituminous adhesive used to affix permanent pavement markers to the pavement shall be one of those listed in List V-2 of the Department's manual "Materials, Sources, and Devices with Special Acceptance Requirements."

The adhesive used to affix the temporary markers to the pavement shall be any suitable type of adhesive for the intended purpose, except that in those locations where the markers will be required to be removed, the adhesive shall be a type that will allow for the complete removal of the marker without scarring or disfiguring the pavement.

SECTION 889
ROADWAY LIGHTING MATERIALS

889.01 General.

Electrical materials shall conform to the requirements given in the current edition of the NFPA 70, "National Electrical Code" (NEC). Electrical materials shall also conform to the standards of the American National Standards Institute (ANSI), the National Electrical Manufacturers Association (NEMA), and the Underwriters Laboratories, Inc. (UL), in every case where a standard has been established. All materials shall be "listed" by one or more of these organizations. The mark of the listing organization shall appear on electrical material and equipment.

Units of any one item (such as poles, luminaires, lamps, control devices, enclosures, circuit breakers, etc.) shall be made by the same manufacturer.

889.02 Conduit.

(a) Rigid Metal Conduit (RMC).

Rigid metal conduit, couplings, and fittings shall be galvanized steel, meeting the requirements given in UL 6. Couplings and fittings shall be threaded.

(b) Liquidtight Flexible Metal Conduit (LFMC).

Liquidtight flexible metal conduit shall meet the requirements given in UL 360. The thermoplastic covering shall be oil resistant.

(c) Liquidtight Flexible Non-Metallic Conduit (LFNC).

Liquidtight flexible non-metallic conduit shall meet the requirements given in UL 1660.

(d) Rigid Nonmetallic Conduit (RNC).

Rigid nonmetallic conduit shall be Schedule 40 PVC and shall meet the requirements given in UL 651.

(e) Nonmetallic Underground Conduit with Conductors (NUCC).

Nonmetallic Underground Conduit with Conductors (NUCC) shall meet the requirements given in UL 1990.

889.03 Lighting Circuit Conductors.

(a) General.

All conductors in the lighting circuits shall be stranded copper with 600 Volt-AC insulation rating. Insulated conductors shall be Type RHW, RHW-2, XHHW or XHHW-2 meeting the requirements given in UL 44. The size of the conductor, voltage rating, and insulation type shall all be clearly marked on the conductor in a color that contrasts with the insulation color.

(b) Conductor Identification Color.

Unless designated otherwise by the requirements given in the NEC, conductors shall be identified as follows. Equipment grounding conductors shall be bare or shall be identified by a continuous green color insulation. Grounded conductors (neutrals) shall be identified by continuous white or gray color insulation. Current carrying conductors may be identified by any color insulation other than white, gray or green and shall have a consistent color for each conductor.

(c) Splicing and Termination of Conductors.

Splices and terminations shall be made with materials which are listed for that purpose. Grounding conductors shall be connected to structures using materials specifically listed for grounding.

(d) Conductors in Luminaire Poles.

The Contractor shall furnish and install the conductors, connectors and fittings in the luminaire poles for supplying power to the luminaries. The required details of the conductors, connectors and fittings are shown on the plans.

889.04 Fuses and Fuse Holders At Breakaway Luminaire Supports.

(a) Fuses

Fuses for installation within fuse holders for the protection of lighting branch circuits shall be small-dimension cylindrical fuses designed for fast acting current limiting. The fuses shall be rated for 600 volts AC and shall have a UL listed interrupting rating of not less than 10,000 rms symmetrical amperes at rated voltage.

Fuses for luminaires shall be rated at 300% of the starting or operating current, whichever is greater, but in no case greater than the branch circuit conductor ampacity.

(b) Fuseholders.

The fuse holder shall be capable of disconnecting upon sufficient tension in the connected wires, as in a pole knockdown. The fuse shall remain enclosed in the de-energized portion of the fuse holder upon disconnection. The fuse shall not be utilized as the disconnection means; a separate plug and receptacle shall be utilized for the disconnection means.

The fuse holder assembly shall connect to the load-side quick disconnect receptacle.

889.05 Junction Boxes.

(a) Non-Metallic Box.

Non-metallic junction boxes shall be made from polymer concrete. With approval of the Engineer, slight deviations to a larger size box may be allowed to conform to a standard manufacturer's production size. The cover shall be attached with stainless steel hex-head bolts factory coated with anti-seize compound.

A box installed at grade shall be capable of withstanding an A16 loading in accordance with the requirements given in ASTM C 857. The box and lid shall be a light gray color to match the surrounding concrete. The box shall be constructed with an open bottom. The cover shall fit flush with the surface shown on the plans.

A box installed in a structure (such as concrete barrier rail) shall have the exposed face of the box flush with the surface of the structure. If the size of the box is not shown on the plans, the minimum size shall be 12 inches {300 mm} long by 10 inches {250 mm} wide by 5 inches {125 mm} deep. Conduit openings may be factory cut.

(b) Metallic Box.

Metallic junction boxes shall be aluminum or stainless steel NEMA Type 4 unless shown otherwise on the plans. A grounding lug shall be provided for the connection of the equipment grounding conductors. Metallic boxes shall be installed only above ground and shall be suitable for surface mounting.

889.06 Service Pole.

Service poles shall be treated in accordance with the requirements given in Section 833.

889.07 Lighting Control Center.

(a) Cabinet.

An aluminum identification plate shall be permanently affixed to the outside of the cabinet door. The identification plate shall be sized to provide the message "Alabama Department of Transportation Lighting Control Center *" either etched or embossed in 1 inch {25 mm} high letters. The identification (A, B, C, etc.) of the lighting control center shown on the plans shall be placed on the identification plate where * is shown in the description of the wording required on the identification plate. The letters shall be delineated in black enamel.

The control cabinet shall be constructed of 0.125 inch {3.175 mm} thick Aluminum unless shown otherwise on the plans and shall be rated NEMA Type 3R. Each cabinet shall be provided with a 12 gauge steel interior panel for mounting of components.

The cabinet shall not be smaller than the minimum dimensions shown on the plans. The cabinet shall be large enough to adequately house all required components with room for arrangement and termination of wiring and room for the inclusion of space for two future lighting circuits.

The cabinet door shall be mounted to the cabinet with a continuous hinge, located on either side of the cabinet (right-hand or left-hand door opening). The cabinet door shall also have a handle-operated three-point latching system located on the opposite side of the continuous door hinge. The door handle shall contain a “Corbin”, or an approved equal, lock with two keys (keys shall match state keying system). The Contractor shall give the keys to the Engineer when the project has been completed, tested, and accepted.

(b) Photocell Control.

The photocell shall consist of a metal electrode, molecularly bonded to a ceramic wafer, and coated with cadmium-sulfide. The photo cell shall be highly corrosion resistant without "plastic dipping". Color response of the cell shall be such that a maximum sensitivity is in the blue-green portion of the color spectrum. The photocell shall be of a solid state design. In addition, the photocell shall meet the requirements of UL 773.

The "On-Off" switching operations shall be accomplished by a normally closed contact which will be operated by means of an electro-magnetic relay. The response time shall be less than one second time delay for turn-on and three to thirty seconds time delay to prevent the "Turn-off" due to lightning flashes. If the photocell fails, the luminaires shall remain on as a notification of needed maintenance.

Over voltage protection shall be provided for the control components and the load circuit by the means of an expulsion type surge arrester capable of passing the surge outlined in ANSI C136.10, except follow current is 10,000 A.

The base of the unit shall be manufactured on a 3 inch {75 mm} wide, solid thermoset phenolic base. The bottom of the base shall have an integral, locking type, brass 3 prong plug according to NEMA specification SH16-1962. The gasket shall be of a cross-linked polyethylene to assure moisture proof seal to the luminaire socket.

The control must be able to operate over the range of 105-130V, 60 Hz. AC (120 V Nominal). Its direct load rating shall be 1000 Watts incandescent load and 1800 VA Mercury Vapor, High Pressure Sodium or other H.I.D. load.

The control shall be stable and reliable over an operating temperature range of -65 ˚F {-55 ˚C} to 158 ˚F {70 ˚C}.

Each control furnished shall be calibrated for a "Turn-on" setting of 2.6 footcandles and the "Turn-off" setting shall not exceed 0.6 times the "Turn-on" setting.

(c) Surge Arrestor.

The surge arrestor shall be weatherproof. It shall be capable of withstanding a surge current of 50,000 Amps and a surge voltage of 550 Volts.

(d) Circuit Breakers.

All feeders, branch circuits, and auxiliary and control circuits shall have overcurrent protection. The overcurrent protection shall be by means of circuit breakers. Circuit breakers shall be standard UL-listed, molded case, thermal-magnetic, bolt-on type, with trip-free indicating handles. Circuit breakers shall have a UL-listed interrupting rating of not less than 22,000 rms symmetrical amperes at rated circuit voltage for which the breaker is applied (unless otherwise noted on the drawings). Multi-pole circuit breakers larger than 100 ampere size shall have adjustable magnetic trip settings. The number of branch circuit breakers shall be as indicated on the Control Cabinet detail drawing or as indicated in the lighting system wiring diagram, whichever is greater, plus space for 2 spare circuit breakers. Circuit breakers shall be installed so that they will be in sequential order from left to right, top to bottom when the circuit breakers are viewed in the open cabinet. The sequential order shall be based on the identifying designation shown on the plans for each lighting circuit.

(e) Contactors.

Contactors shall be electrically operated, mechanically held, as specified, with the number of poles required for the service and with operating coil voltage as indicated. Ampere rating of contactors shall be not less than required for the duty shown and shall otherwise be rated as indicated. Contactors shall be complete with a non-conducting inorganic, non-asbestos subpanel for mounting. Contactors shall be mechanically held and shall be complete with coil-clearing contacts to interrupt current through the coil once the contactor is held in position. The main contactor contacts shall be the double break, silver to silver type. They shall be spring-loaded and provide a wiping action when opening and closing. The contacts shall be renewable from the front panel, self-aligning, and protected by auxiliary arcing contacts. The line and load terminals shall be pressure type terminals of copper construction and of the proper size for the ampere rating of the contactor. A lever for manual operation shall be incorporated in the contactor. Protection from accidental contact with current-carrying parts when operating the contactor manually shall be provided. The contactor operating coil shall operate at 120 V AC, single phase.

The number of lighting contactors shall be as indicated on the Control Cabinet detail drawing or as indicated in the lighting system wiring diagram, whichever is greater, plus space for 2 spare contactors.

All contactors shall be connected to the conductors with the line side on top of the contactor and the load side on bottom.

(f) Ground and Neutral Buss Bars.

Separate ground and neutral bus bars shall be provided. The ground bus bar shall be copper, mounted on the equipment panel, fitted with 22 connectors, minimum, of the type shown on the plans. The neutral bar shall be similar. The heads of connector screws shall be painted white for neutral bar connectors and green for ground bar connectors.

(g) Interior Power, Lighting and Receptacle.

The cabinet shall have an auxiliary device circuit at 120 V AC, single phase to supply a ground fault interrupting, duplex convenience receptacle, a fluorescent cabinet light and photocell for the lighting system. The 120 V, single phase AC power shall be provided by a NEMA 3R rated dry type, 480/120 Volt-AC step-down transformer, not less than 2 kVA, which shall be mounted on the 12 gauge steel interior panel in the cabinet. The auxiliary device circuit, including transformer primary and secondary, shall

have overcurrent protection according to NEC requirements. The fluorescent light shall be a 17 W minimum surface mounted fixture with protected lamp cover and directly connected to a door actuated switch. The receptacle shall be a 20 A, ground fault interrupting, duplex receptacle, in a weatherproof box with appropriate cover.

(h) Wiring and Identification.

Power wiring within the cabinet shall be of the size specified for the corresponding service conductors and branch circuits and shall be rated RHH/RHW, 600 Volts-AC. Control and auxiliary circuit wiring shall be rated RHH/RHW or MTW with jacket, 600 Volts-AC. All power and control wiring shall be stranded copper. When the contract drawings do not specifically indicate assigned wire designations, the manufacturer shall assign wire designations and indicate them on the shop drawings. All switches, controls and the like shall be identified both as to function and position (as applicable) by means of engraved 2-color nameplates attached with screws, or where nameplates are not possible in the judgment of the Engineer, by the use of cloth-backed adhesive labels as approved by the Engineer. The cabinet with all of its electrical components and parts shall be assembled in a neat orderly fashion. All of the electrical conductors shall be installed in a trim, neat, professional manner. The conductors shall be trained in straight horizontal and vertical directions and be parallel, and adjacent to other conductors. Conductors in common paths shall be tied together in a bundle to reduce the number of loose conductors.

(i) Test Switch.

The test switch (selector switch) shall be a standard duty maintained contact control station and shall have double break contacts rated for use on 120 volt AC. The switch shall be labeled “Manual”, “Off”, and “Auto”. Suitable accessories shall be provided for mounting the test switch in the lighting control cabinet.

(j) Schematic Diagram.

The Contractor shall furnish and install a schematic diagram of the control center wiring for each lighting control cabinet. The schematic shall be overlaid with a 10 mil clear laminate and attached to the inside of the control cabinet door using double stick tape or other approved method. The maximum size of the schematic diagram shall be 11 inches by 17 inches.

889.08 Roadway Luminaire Assembly.

(a) Luminaire.

1. General.

The bottom outside of each luminaire shall be marked as shown on the plans or as directed by the Engineer with a permanent marking to provide an identification of the wattage of the luminaire. This designation shall be large enough so that it can easily be seen from the ground after the luminaire is installed.

All luminaires shall have a die cast aluminum housing; a weather resistant gray finish coat applied to the housing unless otherwise stated; a precision formed aluminum reflector coated to prevent tarnish and corrosion; and a pressed borosilicate glass refractor to provide the IES lighting pattern indicated. All hinges, bolts, nuts, washers, screws and miscellaneous hardware shall be stainless steel.

All luminaires shall have labels indicating it is suitable for use in wet locations, suitable for 40 °C ambient temperatures, and suitable for -40 °C starting.

Luminaires other than those shown on the plans may be proposed for use on this project. These luminaires shall produce the lighting levels and ratios shown on the Lighting Design Criteria table in the plans. If a table is not shown, the levels and ratios shall conform to the AASHTO requirements given in the booklet An Informational Guide for Roadway Lighting. Luminaire light distribution classifications are as described in the AASHTO Lighting Design Guide publication

2. Offset Luminaire.

The luminaire shall be an offset type roadway fixture specifically designed for roadway lighting. Support shall be by means of a nominal 2-inch {50.8 mm} knuckle fitter or trunion yoke that allows the luminaire to be easily aimed in both a vertical and horizontal direction.

The lamp socket shall be provided with a quick disconnect for removal of the reflector/socket assembly. All electrical control components shall be completely removable without tools. A terminal block shall be provided for connection to the power source. The luminaire shall be sunlight

resistant, shall be provided with 600 V AC rated conductors, and shall be provided with seals and gaskets to prevent entry of contaminants.

3. Segmented Reflector Luminaire.

The general requirements for a luminaire shall be modified as indicated herein for a segmented reflector luminaire only. The housing shall be square or round heavy gauge aluminum with a vinyl coating or equal means of corrosion protection. The tempered clear glass lens shall be gasketed and securely fastened. A gasketed cast aluminum slip fitter shall accept a 2.375 inch {60.33 mm} O.D. pipe for mounting. The housing and slip fitter shall be substantially made to withstand the anticipated wind loads. The entire unit shall be UL listed as suitable for wet locations and sealed sufficiently to prevent the entrance of insects especially into the lens area.

The luminaire optical assembly shall produce an asymmetrical, square, or rectangular pattern as required by its location. The pattern shall be field adjustable to provide maximum utilization. The HPS lamp shall mount in a vertical base position and produce a cutoff lighting pattern. The maximum candlepower at nadir for a 400 Watt HPS lamp shall be less than 1250. The angle of peak candlepower shall be between 63 and 68 degrees in the vertical plane. The ballast shall be easily removable for maintenance and all wiring shall terminate on a terminal strip.

The luminaire shall be mounted as shown on the plans.

The luminaire shall be designed for a high pressure sodium, clear lamp of the wattage specified in the plans.

4. Light Emitting Diode Luminaire.

The housing shall be die cast aluminum with a weather resistant gray finish coat applied to the housing. The luminaire shall be provided with a hinged door assembly underneath the fixture. The door shall contain all of the electronic components with quick disconnect connectors.

Input supply wires should not need to be bent or re-routed around components to make the electrical terminations. Only copper wire shall be used to connect electronics within the fixture. No wire nuts shall be used within the luminaire assembly.

The luminaire shall utilize heat sink fins that are integrally cast with the housing to maximize heat transfer and minimize thermal impacts of environmental conditions such as debris clogged fins. Thermal management must be passive with no fans or other mechanical devices. The luminaire shall have a minimum heat sink surface such that the LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature. All exposed hinges, bolts, nuts, washers, screws and miscellaneous hardware shall be stainless steel.

All luminaires shall have labels indicating it is suitable for use in wet locations, suitable for 40 °C ambient temperatures, and suitable for -40 °C starting.

The luminaire shall be designed for light-emitting diodes to be mounted on removable modular boards with quick disconnect connectors and mounted to heat sinks using screws. Thermal grease shall not be used. Each LED module shall be fitted with a non-removable lens or individual lenses may be used on each LED die. No additional lens shall be used for the luminaire. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.

The luminaire shall be protected by an integral surge protection device tested in accordance with ANSI/IEEE standard C62.4 for standard and optional waveforms defined in ANSI/IEEE C62.41.2 location category C (High) for 10 KV Basic Impulse Level (BIL). Both common and differential mode protection shall be provided. The failure mode of the surge protector shall be to turn the luminaire off. The protector shall be field replaceable in the event of failure and shall automatically reset after operation with no manual intervention required.

Luminaires shall be provided with a 5-year manufacturer's warranty covering replacement and repair of LEDs, drivers and paint finish. The warranty shall not be affected by opening the power door and accessing the electrical cavity. The manufacturer must have tested the luminaire model in a suitable testing program incorporating high heat, high humidity, thermal shock and vibration testing to ensure reliability and substantiate lifetime claims.

Luminaire compliance and performance claims shall be independently certified by an approved U.S. Department of Energy National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory in accordance with Illuminating Engineering Society of North America (IESNA) LM-79 and LM-80. The luminaire will have long term lumen maintenance documented according to the most current version of Illuminating Engineering Society of North America (IESNA) TM-21.

(b) Ballast.

The ballast shall be capable of starting and operating one lamp of the indicated size from a 60Hz source at the proper voltage. The ballast shall be in full compliance with the lamp/ballast specifications from the lamp manufacturer. The igniter shall be a "Protected Starter" designed to remove the ballast from the circuit three to ten minutes after lamp fails to ignite; or, the igniter may be a type which directs the voltage spike to the lamp without being circuited through the ballast windings. A cycling or extinguished lamp shall not adversely affect the igniter or ballast which shall have an expected life exceeding five years in normal use.

The ballast design center shall not vary more than ± 5% from rated lamp watts for nominal line voltage and nominal lamp voltage.

The lamp wattage regulation spread at any lamp voltage, from nominal through end of rated life, shall not exceed 35% for ± 10% line voltage variation. The ballast must reliably start and operate the lamp in ambient temperatures down to -40 °C for the rated life of the lamp. The ballast primary current during starting must not exceed normal operating current. The ballast shall be capable of sustaining lamp operation with a line voltage dip or sag of 35% for up to 4 seconds when operating a nominal voltage lamp with nominal line voltage applied to the ballast primary. The line power factor of the lamp/ballast system shall not drop below 70% for ± 10% line voltage variations at any point in the lamp life.

(c) Light Emitting Diode Driver.

The driver shall be capable of starting and operating the LED modules of the indicated size from a 60Hz ±3 Hz source at the designed voltage ±5%. The driver output shall not vary more than ± 5% from rated output watts for nominal line voltage and nominal lamp voltage.

Driver shall have a minimum power factor of 90% and a maximum Total Harmonic Distortion (THD) of 20% at full power output. The operating frequency should be high enough to avoid visible flicker in the light output. The driver shall be UL certified for use in dry or damp locations. Driver life expectancy shall be 50,000 hours at 80 °C and 100,000 hours at 70 °C. The driver will not be adversely affected by the cycling or failure of one or more LED modules during the life of the driver.

The driver must reliably start and operate the lamp in ambient temperatures from -40 °C to 40 °C for the rated life of the lamp. The driver shall be capable of sustaining LED operation with a line voltage dip or sag of 35% for up to 4 seconds.

(d) Lamp.

Each luminaire shall have a clear high pressure sodium (HPS) lamp of the required wattage installed. Average lamp life shall be 24,000 hours. Initial lumen output shall be:

70 Watts - 5,800 lumens	400 Watts - 50,000 lumens
100 Watts - 9,500 lumens	600 Watts - 92,000 lumens
150 Watts - 16,000 lumens	250 Watts - 28,000 lumens

(e) Light Emitting Diode.

Each LED should be rated for a minimum operational life of 50,000 hours at 40 °C and comply with IESNA L-85 standards at 20 °C ambient temperature. Photometry must be in compliance with IESNA LM-79 when operating at an ambient temperature of 25 °C. The LED module shall lose no more than 10% optical intensity when operating at 40 °C than its initial delivered lumens at 25 °C.

All LED modules shall be constructed so that the failure of one LED will not result in the loss of the entire luminaire and so that modules can be replaced without replacing the entire luminaire. Each LED die or the LED module should be enclosed in a non-removable transparent lens of either glass or acrylic. The LED module shall produce a nominal correlated color temperature of 4000K ±275K with a color rendering index of at least 70 and a minimum output of 80 lumens per watt efficacy.

(f) Roadway Luminaire Lowering Device.

1. Reliability Of Lowering Device .

Any lowering device proposed for use shall have been proven reliable through previous acceptable performance. Lowering devices that are unreliable and have excessive maintenance costs in previous installations will not be approved for installation. Upon request by the Engineer, the Contractor shall furnish a list of at least ten installations, locations, and telephone numbers of persons to contact to verify the performance of the lowering device. Any delays in the progress of construction due to the Contractor's failure to furnish the requested information concerning the proposed lowering device shall be the responsibility of the Contractor.

2. Required Configuration Of Lowering Device.

The lowering device for a roadway luminaire assembly shall be configured to simultaneously raise or lower two or more luminaires that are attached to a single rigid assembly.

All exterior metal components of the lowering device shall be of corrosive resistant materials including stainless steel, aluminum, or galvanized steel unless otherwise specified. Other metal parts of the lowering device shall be of the quality recommended by the manufacturer for the proper functioning of the device.

The lowering device shall be capable of being latched at the top of the luminaire assembly to take the load of the luminaires and mounting hardware off of the cables at the final mounting height. The latching system shall be designed to impart no more than one G of force to any component of the roadway luminaire assembly.

The lowering device shall have a centering mechanism that will reliably keep the orientation of the luminaires in the proper position at all times until final latching is complete.

The raising and lowering shall be accomplished by the use of a portable winch and motor assembly that is connected by cord and plug to the electrical power for luminaires. The winch shall have a gear reduction assembly to allow a smooth, slow raising and lowering operation. The raising and lowering shall be accomplished by the use of stainless steel aircraft cable(s). The number of required cables shall be determined by the lowering device manufacturer. Each cable shall have at least 7 strands of 19 wires.

The Contractor shall provide one portable winch and motor assembly for State retention.

The safety factor for the winch, motor, cables, raising and lowering assembly, and mounting hardware shall have a loading capacity of at least five times the weight that is carried by the cables.

(e) Luminaire Poles and Pole Foundations.

The details of the luminaire poles and foundations are shown on the plans. Additional requirements are given in Sections 718 and 891.

(f) Breakaway Supports.

A frangible base that meets the requirements given in NCHRP 350 shall be installed on each luminaire assembly when shown on the plans. Breakaway Couplings will be allowed if shown on the plans. The Contractor shall assure the compatibility of the pole base, breakaway support, and foundation.

889.09 High Mast Luminaire Assembly.

(a) High Mast Luminaire.

The lighting distribution requirements for a high mast luminaire shall be the same as those given for a roadway luminaire.

Each high mast luminaire shall consist of cast aluminum housing, built in ballast and a one piece reflector assembly. The housing shall contain a slip fitter for a 2-inch {50.8 mm} horizontal pipe tenon which allows adjustment for leveling. All ballast components shall be accessible from the top with the luminaire mounted and aimed. The ballast shall be pre-wired to a terminal block using quick disconnect fittings. The luminaire and ballast shall be from the same manufacturer.

The optical assembly reflector shall be borosilicate glass encased within a spun on, sealed aluminum cover or a formed aluminum reflector with a chemically bonded lightweight non-breakable 95% silica glass finish. The reflector shall be designed to direct light away from the lamp arc tube. The lamp shall operate in the vertical base up position. If an enclosed and filtered optical assembly is shown to be required on the plans it shall include a hinged lens ring and a heat/impact-resistant flat glass lens held in place by four spring clamps.

The luminaire shall provide the ANSI/IES type distribution as required by the plans and have a minimum efficiency of 69% of base lamp lumens in the 0-90 degree zone.

Lamps shall be the same as those required for a Roadway Luminaire Assembly.

The performance requirements for ballast shall be those given for a Roadway Luminaire Assembly.

(b) Light Emitting Diode High Mast Luminaire.

The requirements for a light emitting diode high mast luminaire shall be the same as those for a light emitting diode roadway luminaires. The housing shall contain a slip fitter for a 2-inch {50.8 mm} horizontal pipe tenon which allows adjustment for leveling. All drivers and internal components shall be accessible from the top with the luminaire mounted and aimed. The driver shall be pre-wired to a terminal block using quick disconnect fittings. The luminaire and driver shall be from the same manufacturer.

The requirements for high mast light emitting diodes shall be the same as those required for roadway light emitting diodes. The requirements for light emitting diode high mast drivers shall be the same as those given for a light emitting diode driver.

(c) High Mast Luminaire Lowering Device.

1. Reliability of Lowering Device.

Any lowering device proposed for use shall have been proven reliable by satisfactorily performing its function. Failure to operate properly or undue maintenance costs history in previous installations shall be grounds for disqualification of a particular product. Upon request, a list of up to ten installations, locations, and telephone numbers of persons to contact to verify this shall be provided. Any delays in the project schedule due to meeting these requirements shall be the responsibility of the Contractor.

2. Required Configuration of Lowering Device.

Each high mast lluminaire assembly shall be furnished with a lowering device, suitable for lowering a luminaire mounting ring, which will allow the complete luminaire and associated electrical and mechanical apparatus to be serviced from not more than 5 feet {1.52 m} above the base plate. The luminaire mounting ring shall be raised and lowered by multiple stainless steel wire rope cables each of which shall be capable of supporting the entire mounting ring assembly under design wind loading conditions. The wire rope cables shall be stainless steel with each cable having at least 7 strands of 19 wires.

The power feed conductors shall be terminated in an aluminum or stainless steel NEMA 4 junction box using strain relief conductor clamps. "Kellums" type grips are not acceptable. The luminaire ring shall provide a totally enclosed wireway in which to route the conductors to each luminaire mount. An approved means shall be provided to insure smooth and non-damaging travel up and down the pole. The ring shall be securely positioned in its final location at the top of the pole.

The drive assembly for each high mast luminaire assembly shall consist of a single or twin drum at least 20 nominal wire rope diameters in size. It shall have an AGMA rated winch assembly with sufficient reduction to obtain self-locking when traveling in either direction. The use of sprockets and chains will not be accepted. The winch shall be driven by a drill motor or other motor equipped with a torque limiting safety clutch and a remote operator on a minimum 15 foot {4.57 m} long cord. Power for the motor shall be obtained through the circuit breaker conductors using an appropriate step-down transformer with a matching connector. The drive unit and complete lowering assembly shall be designed for the operator to raise the ring to the point the safety clutch begins to slip without damage to the mounting ring, the wire rope cables, or the pole top assembly.

The Contractor shall provide one electric motor and lowering apparatus for State retention.

Minimum thread diameters of the sheaves over which run the lowering cables shall be at least 25 times the nominal rope diameter. The nominal rope diameter of nylon jacketed wire rope shall be the core or unjacketed rope nominal diameter. The sheave grooves shall be semi-circular in cross section. The radius of the groove shall be one-half the nominal diameter of the rope plus 1/64 th of an inch {0.397 of a mm}. Provisions shall be made to prevent the lowering cables from leaving the sheave grooves.

All components and hardware shall be galvanized or stainless steel.

3. Latch Device.

All latching devices shall be at the top of the pole. The pole top latch shall hold the lowering ring securely in position at the top of the pole by means of three symmetrically placed latches located on the head assembly with flags to indicate the locked or unlocked position. Each of the three latches shall latch and unlatch independently of the other two latches.

4. High Mast Poles and Foundations.

The details of the high mast poles and foundations are shown on the plans. Additional requirements are given in Sections 718 and 891.

SECTION 890
TRAFFIC SIGNAL EQUIPMENT

890.01 General.

The following are the requirements for traffic signal equipment. These requirements may be supplemented or amended by the requirements given elsewhere in the proposal, on the plans, and on the details in the Special and Standard Highway Drawings.

Requirements specified in these specifications shall comply with the latest editions of the NEC, and NESC. All equipment shall conform to the requirements of these specifications. Where cited Standard Publications and these specifications differ, the requirements of these specifications shall govern. For purposes of these specifications wherever the following terms or abbreviations are used, the meaning shall be interpreted as follows:

A	Amps
AC	Alternating Current
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWG	American Wire Gage
DC	Direct Current
Hz	Hertz
IMSA	International Municipal Signal Association
ITE	Institute of Transportation Engineers
LED	Light Emitting Diode
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufactures Association
NESC	National Electrical Safety Code
UL	Underwriters Laboratories
V	Volts
VA	Volt Amps
W	Watts

Descriptions and definitions of the equipment, words, and terminology used in these specifications are given in the MUTCD, the NEMA TS 2-2016 Standards Publication, ITE publications, and the NEC.

890.02 Controller Unit.

Regardless of controller assembly type, all controller units shall be Advanced Transportation Controllers (ATC) conforming to this specification.

(a) General Requirements.

Advanced Transportation Controller (ATC) shall conform to the controller standard ATC 5201 v06.25 or later and requirements outlined in this specification. Where this specification and cited standards differ the requirements of this specification shall govern.

Advanced Transportation Controllers used by the Alabama Department of Transportation (ALDOT) shall be on the MSDSAR.

(b) Functional Requirements.

The controller shall be NTCIP conformant for its application, conforming to the mandatory functional requirements of the latest NTCIP standards, unless otherwise specified. For the controller to be compliant with these specifications, the controller shall comply with the Protocol Requirement List (PRL) for the project. The PRL will indicate which mandatory and optional NTCIP functional requirements shall be required. A Protocol Implementation Conformance Statement (PICS) shall be supplied by the manufacturer with the material submittal to verify compliance with this specification and to indicate NTCIP functional requirements supported by the controller. The controller Application Programming Interface (API) shall conform to the API standard ATC 5401v02.17 or later. The controller shall be supplied with a printed and bound operations manual/maintenance manual containing circuit component schematics and programing instructions.

A second copy of this information shall be provided on a thumb drive, CD or DVD ROM. All other functional requirements of the controller shall fully comply with the mandated requirements of the ATC Controller Standard 5201 V06.25 or later.

(c) Engine Board Details.

The SD Card socket referenced in ATC 5201 v06.25 shall be provided on the Engine Board. Any suitable electrical interface may be used. Physical access to this socket external to the controller is not required but is permitted.

All other Engine Board details shall fully comply with the mandated requirements of ATC 5201 V06.25 or later.

(d) Communication Interface Details.

ATC shall have a minimum of one communication interface slot conforming to ATC 5201 v06.25 or later.

ATC communications cards shall be available for the following protocols:

Public line, dial-up
Single Mode Fiber
License Free Radio
Ethernet

All other communication shall fully comply with the mandated requirements of the ATC Controller Standard 5201 V06.25 or later.

(e) User Interface, Power Supply and Mechanical Details.

All controllers shall be the keyboard entry type. The front panel keypad shall facilitate the entry of interval timing. All controllers shall be capable of timing entries via the keypad and via computer download, without need to open the unit and without special tools.

The controller shall have a power switch. Power supplies, cables, and connectors shall be required as needed to provide power to the controller unit in the controller assembly.

All other User Interface, Power Supply and Mechanical Details shall fully comply with the mandated requirements of the ATC Controller Standard 5201 V06.25 or later.

(f) Parallel and Serial I/O Details.

Parallel and Serial I/O details shall conform to ATC 5201 v06.25 or later based on the cabinet type.

Parallel and Serial Input/output connections shall be supplied as required to support the cabinet environment and provide a fully functional controller assembly.

(g) Environmental and Test Procedures.

Environmental and Test Procedures shall fully comply with the mandated requirements of ATC 5201 V06.25 or later.

1. ATC communications cards shall be available for environmental testing for the following protocols:

Public line, dial-up
Single Mode Fiber
License Free Radio
Ethernet

890.03 Controller Assembly.

The controller assembly shall be configured and bench-tested prior to installing the controller assembly. A Traffic Signal Technician from the State Signal Shop shall inspect the controller assembly prior to turning on the system.

(a) Description.

A controller assembly shall consist of a controller unit, conflict monitor, auxiliary devices, electrical devices, and other equipment as specified in the specifications, plans, or proposals, mounted and wired into a cabinet to make a complete operational traffic controller assembly.

The plans will indicate type of controller assembly required.

(b) Controller Assembly Type.

Controller Assemblies shall be classified in the following categories:

Type NEMA: NEMA TS2 Type 1 Cabinet with ATC
Type ATC: ATC Cabinet Standard Latest Version with ATC

890.04 Type NEMA Controller Assembly.

(a) Requirements.

All Type NEMA Controller Assemblies shall be NEMA TS 2 Type 1 and shall meet as a minimum, all applicable sections of NEMA Standards Publication TS 2-2016, latest version. Where differences occur, this specification shall govern.

(b) Cabinet.

The cabinet shall be designed for base mount or pole mount as shown on the plans. The cabinet shall be clean-cut in design and appearance and conform to NEMA Standard TS 2-2016, latest version, and these specifications. Where differences occur, this specification shall govern.

1. Fabrication Material.

   The cabinet shall be fabricated from shaped sheet aluminum.

2. Cabinet Dimensions.

   Unless otherwise indicated in the plans or proposal, pole mounted controller cabinets shall meet the dimensional requirements for a Size 5 cabinet per NEMA Standard TS 2-2016 or later.

   Unless otherwise indicated in the plans or proposal, base mounted controller cabinets shall meet the dimensional requirements for a Size 6 cabinet per NEMA Standard TS 2-2016 or later.

   The cabinet shall be large enough to provide ample space to house the controller unit, conflict monitor, auxiliary devices, electrical devices, and other equipment as specified in these specifications, plans or proposals.

   An alternative cabinet size may be used if a written request is submitted and approved.

   All cabinets shall be meet industry design standards.

3. Doors.

   Doors shall comply with NEMA Standard TS 2-2016, latest version.

4. Gasketing.

   Gaskets shall comply with NEMA Standard TS 2-2016, latest version. Gaskets shall be supported in a channel to prevent gasket fatigue/sagging.

5. Locks and Keys.

   Shall comply with NEMA Standard TS 2-2016, latest version.

6. Shelves.

   The cabinet shall be supplied with at least two mounting shelves. The shelves shall comply with the requirements of NEMA TS 2-2016, latest version.

   For base mounted cabinets a drawer with lid shall be mounted below the bottom shelf for the storage of documents and to provide a work surface suitable for a laptop.

   For pole mounted cabinets a folding shelf mounted to the door shall be provided with a document storage compartment and a work surface suitable for a laptop.

7. Finish and Surface Preparation.

   Unless otherwise shown on the plans, the cabinet shall be aluminum finish and comply with the requirements of NEMA TS 2-2016, latest version.

8. Cabinet Mounting.

   Cabinets shall be pole, base, or pedestal mounted as indicated in the plans and cabinet mounting shall comply with the requirements of NEMA TS 2-2016, latest version.

9. Cabinet Ventilation.

   Cabinet ventilation shall satisfy the requirements of NEMA TS 2-2016. Louvered vents shall be located on the main cabinet door.

   The cabinet vent air filter shall be mounted on door and held firmly against the door by a spring or similar device.

(c) Malfunction Management Unit.

The Malfunction Management Unit (MMU) shall meet MMU2 requirements outlined in NEMA TS2-2016, latest version.

(d) Terminals and Facilities.

Shall meet TS2 Type 1 requirements as specified in NEMA TS2-2016, latest version, with the following additional requirements are listed below.

1. Power Strip

A metal power strip shall be installed within the cabinet to provide clean 120 VAC. This power strip shall be in addition to the convenience receptacle. The power strip shall contain a minimum of 4 NEMA 5-15R receptacles spaced approximately 2.5 inches center to center. The sockets shall be arranged along a single axis with the blade sockets oriented perpendicular to that axis.

2. Light Fixture.

Cabinet lighting shall be LED and meet the requirements of NEMA TS 2-2016, latest version.

The light on/off switch shall be a door actuated switch that turns the light On when the door is open and Off when the door is closed.

3. Police Panel Switches.

The police panel shall contain only two switches, a SIGNAL ON/OFF switch, and an AUTO/FLASH switch.

Switches shall be clearly and permanently labeled.

The SIGNAL ON/OFF switch shall disconnect flasher and load switch outputs to the field and set Stop Time when switched to the OFF position. The signal shall follow the programmed startup sequence when returning from a dark condition.

The AUTO/FLASH switch shall operate in accordance with NEMA TS2-2016. The signal shall return from flashing operation in accordance with the MUTCD.

There shall be no remote plug-in or manual control enable switch contained within the police panel area, unless specified in the plans and proposal.

4. Maintenance Panel Switches.

These switches shall be located inside the main cabinet door on the back side of the police compartment. All switches shall be clearly and permanently labeled. The following switches shall be provided: STOP TIME, AUTO/FLASH, SIGNAL ON/OFF.

The STOP TIME switch shall be a two-position switch. The ON position shall manually set Stop Time in the controller. In the OFF position, Stop Time shall be enabled in the monitor.

The AUTO/FLASH switch shall meet the requirements of NEMA TS 2-2016. The signal shall return from flashing operation in accordance with the MUTCD.

The SIGNAL ON/OFF switch shall disconnect flasher and load switch outputs to the field and set Stop Time when switched to the OFF position. The signal shall follow the programmed startup sequence when returning from a dark condition.

A 24VDC override switch shall be provided, as described in NEMA TS2-2016, to manually apply 24VDC to the load switches for diagnostic purposes during flash transfer operations. The switch shall be a spring-loaded push button.

5. Cabinet Main and Auxiliary Circuit Breakers.

The main circuit breaker shall turn off all power to the cabinet.

The main breaker shall be rated at 30 A. Incoming power shall be routed through the main breaker and cabinet suppressor-filter before powering any equipment or devices.

The AC service shall follow a short path to the main breaker and cabinet suppressor-filter. The wiring shall be routed such that no severe bends shall occur along the path to the cabinet suppressor. The auxiliary breaker shall be rated at 15 A and be located beyond the main breaker and cabinet suppressor. A secondary auxiliary breaker rated at 15 A shall be provided and located beyond the main breaker and cabinet suppression to protect a cabinet mounted power strip.

6. Cabinet Suppressor-Filter.

The cabinet shall be supplied with a suppressor, HESCO HE1750R or approved equal.

7. Signal Bus Contactor.

The signal bus contactor shall be a solid-state relay, Struthers-Dunn Model 418AXXL-120VAC, or approved equal.

8. Cabinet Power Supply.

The Cabinet Power Supply (CPS) shall be a shelf mountable unit meeting the requirements of NEMA TS2-2016, latest version.

9. Signal Load Switch Arrestors.

Shall be HESCO HE103C-9 or approved equal.

10. Protection of Loop Detectors (External Surge Protection).

Shall use a three-terminal device, HESCO VLP7 or approved equal, or may opt to use a pluggable device.

If pluggable detection suppression is used it shall be HESCO HE6LC-6 or approved equal.

11. Replacing Transient Protection.

All transient protection devices shall be replaceable without removing any panels.

12. SDLC Bus.

A SDLC Bus shall be provided with a minimum of 7 SDLC connectors.

13. Detector Rack (16 Channel).

Detector Racks provided shall house 1 BIU and be capable of providing 16 channels of detection. Racks shall have 8 positions for combinations of 2 and 4 channel detector cards up to 16 channels of detection or may have 4 positions which allow for up to 16 channels of detection utilizing half width 4 channel detector cards (approx. 1.12" wide).

The rack shall utilize SDLC to interface with the controller.

The detector rack shall be connectorized to accept an input termination panel harness.

14. Input Termination Panel (16 Channel).

A 16 Channel Input Termination Panel shall be provided for each detector rack. The termination panel shall come with a pre-wired harness which connects to the detector rack.

15. Output Facility (16 Channel).

The Output Facility shall be configured for 16 output channels. It shall house 2 BIUs and utilize SDLC to interface with the controller and MMU. The field output wires shall terminate at the bottom of the facility and signal load switch arrestors shall be located directly above the field output terminals.

(e) Auxiliary Devices.

Auxiliary devices as defined in NEMA Standard Publication TS 2-2016, latest version, shall conform to the requirements of NEMA Standard Publication No. TS 2-2016, latest version.

(f) Type NEMA Cabinet Configurations.

Unless otherwise specified, all cabinets shall be configured for 16 output channels. Where detection is required, a minimum of one 16 Channel Detector Rack shall be required. Additional 16 Channel Detector Racks shall be required as needed up to 64 channels of detection. Only load switches and detector cards needed to provide the required signalization and detection shall be required. Detector Racks shall be mounted to the top shelf of the cabinet when possible. Where shelf space is inadequate, compact components may be utilized such as detector racks which support half width BIUs (approx. 1.2" wide) and half width 4 channel detector cards (approx. 1.2" wide).

The Controller, MMU, and CPS shall be placed on the bottom shelf.

Required equipment shall be neatly arranged within the cabinet.

Output facilities shall be mounted on the back of the cabinet near the bottom.

Power distribution components shall be mounted on the right side of the cabinet near the bottom.

The power strip shall be mounted on the right side of the cabinet near the top.

Input termination facilities shall be mounted on the left side of the cabinet.

Terminals and Facilities shall not be mounted less than 6" from the bottom of standard base mount cabinets. Terminals and Facilities shall not be mounted less than 3" from the bottom of standard pole mount cabinets.

A Standard Base Mount Cabinet shall be a NEMA TS2-2016 Size 6 Cabinet (Approx. 52"x44"x24").

A Standard Pole Mount Cabinet shall be a NEMA TS2-2016 Size 5 Cabinet (Approx. 48"x30"x16").

890.05 Type ATC Controller Assembly.

(a) Definitions.

ADU	Auxiliary Display Unit
LV	Low Voltage – 50 Volts DC or less
HV	High Voltage – 120 VAC
CMU	Cabinet Monitor Unit
HDFTR	High Density Flash Transfer Relay
HDSP-FU	High Density Switch Pack / Flasher Unit

PCB Printed Circuit Board
SIU Serial Interface Unit

(b) Requirements.

Type ATC Controller Assemblies shall meet, as a minimum, Advanced Transportation Controller (ATC) Cabinet Standard, latest version. Where differences occur, this specification shall govern.

A Type ATC Controller Assembly shall consist of a Controller Unit, CMU, ADU, Service Assembly, SB1/SB2 and DC Power Bus, AC Clean Power Bus, and Input and Output Assemblies, as required, with associated Termination Assemblies, wired into a cabinet to make a complete and operational Controller Cabinet Assembly.

Assemblies and components shall be provided as indicated in specifications, plans, or proposals.

Assemblies or components not specified or indicated in the plans, which are needed to provide a complete operational controller cabinet assembly shall be provided.

Assemblies shall be rack mountable and completely removable from or installable in the Cabinet Cage without removing any other equipment and using only a standard # 2 Phillips screwdriver.

Assemblies shall be supplied with enough cabling to allow mounting in any position in the cage enabling a neat and clean install.

All wiring shall be routed in such a way that is neat and does not interfere with the installation or removal of other auxiliary or standard components.

All High-voltage components and wiring (over 50 V) shall not be exposed and shall be adequately protected from accidental contact.

All equipment in the cabinet shall be clearly and permanently labeled.

Marker strips shall be provided below item they identify and must be visible after installation.

Marker strips shall be easily written upon with ball point pen or pencil.

Top and bottom guides shall be provided for PCB-based plug-in components.

Circuit breakers, switches, fuses, and indicators shall be visible and accessible when the Cabinet door is open (not behind other equipment).

The cabinet shall be wired in such a way that the intersection can remain in flash while removing the input/output assemblies or controller.

Door switches shall be powered by 24 or 48VDC.

Cables and wiring shall not travel directly from device to device but shall be bundled, managed, and routed along rack rails.

All grounding and neutral cables shall have sufficient slack to allow for future testing with a clamping style meter.

Type ITS Controller Assemblies shall be designed to allow for conversion from 120 VAC to 48 VDC output and vice versa.

(c) Cabinet Housing.

ATC Controller Assembly Cabinet Housings shall meet the requirements specified in Caltrans Transportation Electrical Equipment Specifications 2009 with Errata No. 2, hereafter referred to as TEES 2009.

Cabinet Housings including ventilation, doors, locks, gaskets, etc. shall conform to TEES 2009 Chapter 6 Section 2. The housings shall be constructed of aluminum with stainless steel hardware, and shall have a Natural Finish, unless otherwise specified.

The police panel shall contain only two switches, a SIGNAL ON/OFF switch, and an AUTO/FLASH switch.

Switches shall be clearly and permanently labeled.

The SIGNAL ON/OFF switch shall disconnect flasher and switch pack outputs to the field and set Stop Time when switched to the OFF position. The signal shall follow the programmed startup sequence when returning from a dark condition.

The AUTO/FLASH switch shall allow normal operation when in the AUTO position. In the FLASH position the switch shall set the traffic signal in flashing operation and set stop time. The signal shall return from flashing operation in accordance with the MUTCD.

There shall be no remote plug-in or manual control enable switch contained within the police panel area, unless specified in the plans and proposal.

Cabinets shall have a plaque or other durable label inside the door stating the output voltage of the cabinet.

(d) Cabinet Cage.

The cabinet shall contain an EIA 19-inch rack cage meeting the requirements of TEES 2009 Chapter 6 Section 3; the location of the drawer and assemblies in the cabinet cage shall be as indicated in these specifications unless otherwise specified in plans, contract documents, or proposals.

(e) Cabinet Lighting.

Two LED light sources shall be mounted on the inside of the cabinet, one near the top of the front of the cabinet and one near the top of the back of the cabinet such that they illuminate all equipment mounted in a vertical plane with the front and back of the cabinet rack.

Each light source shall provide a minimum of 700 lumens of visible light.

At turn-on, the lighting fixture shall provide the minimum required lumens of visible light within 30 seconds.

All electrical circuits associated with cabinet lighting shall be protected such that they do not generate radio frequency interference or power line transients that can affect the operation of any equipment located in the cabinet.

On/Off switches for cabinet lighting shall be door actuated switches that turn the lighting on when one or more doors are open and off when all doors are closed.

(f) Cabinet Drawer.

A telescopic slide out drawer for document storage shall be provided for base mount and standard pole mount cabinets. The Drawer Unit shall be mounted across the EIA rails and shall have a non-conductive top, locking provision when fully extended, and lip or handle for pulling. The height of this unit shall be 1U. The mounting location of this drawer shall be as indicated in these specifications unless otherwise specified in the plans, contract documents, or proposals.

(g) Service Assembly.

Cabinets shall contain a 1-HDFU Service Assembly unless a 2-HDFU Service Assembly is required for the cabinet to function properly for the application for which it is specified. A 2-HDFU Service Assembly shall be provided if specified in the plans, contract documents, or proposals.

Breakers located on the service assembly shall be shielded to prevent accidental contact.

The Service Assembly shall be modular and shall be mounted on the left of the EIA rail when viewed from the front.

1. 1-HDFU Service Assembly

The Service Assembly shall house: one HDSP/FU, a Cabinet Suppressor–Filter, BBS landing wire terminals, one GFCI convenience receptacle (duplex NEMA 15-5R format), four 3 Amp HDFU output fuses, five Circuit Breakers, and a Raw AC+ terminal block having 5 screw terminals. The following circuit breakers shall be provided: Main, AC Clean, GFCI/Fans/Lights, FU 1, and Output Assembly. The Main breaker shall be 30A; all others shall be 15A.

2. 2-HDFU Service Assembly

The Service Assembly shall house: two HDSP/FU, a Cabinet Suppressor–Filter, BBS landing wire terminals, one GFCI convenience receptacle (duplex NEMA 15-5R format), eight 3 Amp HDFU output fuses, six Circuit Breakers and a Raw AC+ terminal block having 5 screw terminals. The following circuit breakers shall be provided: Main, AC Clean, GFCI/Fans/Lights, FU 1, FU 2, and Output Assembly. The Main breaker shall be 30A; all others shall be 15A.

(h) AC Clean Power Bus Assembly.

The AC Clean Power Bus shall include eight NEMA 5-15R receptacles, to provide AC Clean Power to the Controller Unit, the Cabinet DC Power Supply, and other assemblies and devices.

The AC Clean Power Bus shall be mounted across the EIA rails on the back of the cabinet cage.

The assembly shall be hinged to allow access to the back of assemblies mounted to the opposite side of the cage.

1. SB1/SB2 and DC Power Bus Assembly.

The SB1/SB2 and DC Power Bus Assembly shall include eight DB25 d-submodular socket connectors to interconnect the SB1/SB2 communication ports of the assemblies and controller. It shall include a termination circuit at the end of the connections (S8) (Serial Bus Through) to prevent radio frequency signal reflection.

The assembly shall have one Phoenix Contact plug block or approved equal to bring power from the Cabinet DC Power Supply to the Bus; DC Power shall be distributed to the Cabinet Assemblies through seven Phoenix Contact receptacle blocks or approved equal. Copper traces for the DC voltages shall support at least 10 Amp.

The SB1/SB2 and DC Power Bus shall be mounted across the EIA rails on the back of the cabinet cage. The assembly shall be hinged to provide easy access to the back of the assemblies mounted to the opposite side of the cage.

(j) Input Assembly (24-48 Channel).

The Input Assembly shall be a 3U high rack mounted assembly providing twelve slots of 22/44 pin PCB sockets.

The Input Assembly rack shall be designed in a manner to prevent bowing or sagging.

The 24 Channel Input Assembly shall contain one Serial Interface Unit (SIU) mated to a DIN 96-pin connector and shall house twelve 2-channel detection modules, or six 4-channel detection modules, or a combination of 2 & 4 channel detection modules up to 24 channels. The 24 Channel Input Assembly shall also have a provision for an Opto Technician Panel on the front of the assembly with four LED call indicators for the Opto circuits in the SIU and four switches to place calls on the Opto circuits in the SIU. A CDC interface shall be provided on the back of the input assembly for interface between the SIU and a four Opto input termination panel. The Opto Technician Panel and termination panel shall be provided as required or if specified in the plans, contract documents, or proposals.

The 48 Channel Input Assembly shall contain 2 SIUs and shall house twelve half-width (approx.1.14”) 4-channel detection modules or a combination of 2 & 4 channel detection modules up to 48 channels of detection. CDC ports shall be provided, for both SIUs, on the back of the 48 Channel

Input Assembly to provide interface with the Opto circuits of the SIUs.

(k) Field Input Termination Assembly (24-Channel).

The 24-Channel Field Input Termination Assembly shall be coupled with the 24-Channel Input Assembly and shall have positions for landing 24, two-wire inputs and their associated earth ground wires. The Field Input Termination Assembly shall have positions for 12 Detection Module Suppressors. Detection Module Suppressors required shall be supplied with the cabinet. The 24-Channel Field Input Termination Assembly shall be mounted across the EIA rails in the back of the cabinet and it shall be hinged to provide access to the back of the assemblies mounted on the opposite side of the cabinet.

Two 24-Channel Field Input Termination Assemblies shall be coupled with a 48-Channel Input Assembly.

(l) Output Assembly (16-32 Channel).

The Output Assembly shall have a STOP TIME (ON/OFF) switch and SIGNALS (AUTO/FLASH) switch on the front of the assembly.

The STOP TIME switch shall be a two position switch. The ON position shall manually set Stop Time in the controller. In the OFF position, Stop Time shall be enabled in the monitor.

The AUTO/FLASH switch shall allow normal operation when in the AUTO position. In the FLASH position the switch shall set the traffic signal in flashing operation and set stop time. The signal shall return from flashing operation in accordance with the MUTCD.

A 24VDC momentary bypass switch shall also be provided on the front of the output assembly to provide 24VDC to the HDSPs for troubleshooting during flash mode.

A 5A breaker shall be provided on the front of the Output Assembly for every 4 channels of output.

Breakers and switches shall be shielded to prevent accidental contact.

The Output Assembly shall accommodate one Cabinet Monitor Unit (CMU).

The Output Assembly shall be easily configurable for 48VDC or 120VAC heads.

1. Output Assembly (16 Channel)

   The Output Assembly shall be a 3U high rack mounted assembly. The Output Assembly shall accommodate eight HDSP/FUs, providing 48 output circuits.

   The Output Assembly shall accommodate one SIU to provide interface and control via system SB1/SB2.

2. Output Assembly (32-Channel)

   The Output Assembly shall be a 6U high rack mounted assembly. The Output Assembly shall house sixteen HDSP/FUs and shall provide ninety-six output circuits.

   The Output Assembly shall accommodate two SIUs to provide interface and control via system SB1/SB2.

(m) Field Output Termination Assembly (16 Channel).

A 16-Channel Field Output Termination Assembly shall be coupled with the 16-Channel Output Assembly and shall house High-Density Flash Transfer Relays (HDFTR). The HDFTRs and Flash Program Blocks (FPB) shall be provided to control and select the color (red, yellow, or dark) during flash mode. HDSP Suppressors shall be provided at the field terminals for the protection of the HDSPs. Each HDFTR position shall be labeled with the number of its associated HDSP (1-16). Each FPB position shall be labeled with the number of its associated channel (1-16)

The Field Output Termination Assembly shall be provided with 16, 6-position Phoenix Contact terminal block model number 18-04-94-6 plugs and 18-61-19-6 sockets or approved equal. Each Load Terminal Block receptacle shall be labeled with the number of its associated channel (1-16). Additional labels shall be provided to clearly indicate which terminals correspond to the red, yellow, and green switch pack outputs. The color of these labels shall match the color of their associated output (red, yellow, or green). One Field Output Termination Assembly shall be provided with each 16-channel cabinet, while two Field Output Termination Assemblies shall be provided with each 32 Channel Output Assembly.

The 16-Channel Field Output Termination Assembly shall be mounted across the EIA rails on the back of the cabinet cage. The assembly shall be hinged to provide access to the HDSP Suppressors, and the back of assemblies mounted to the opposite side of the cabinet cage.

(n) Cabinet Components.

1. High-Density Switch Pack / Flasher Unit (HDSP-FU).
   The HDSP-FU shall be an EDI - Model 2202-HV or approved equal for 120VAC (High Voltage) output cabinets.
   The HDSP-FU shall be an EDI – Model 2202-LV or approved equal for 48VDC (Low Voltage) output cabinets.
2. Cabinet Monitor Unit (CMU).
   The CMU shall be an EDI – Model 2212-HV or approved equal for 120 VAC (High Voltage) output cabinets.
   The CMU shall be an EDI – Model 2212-LV or approved equal for 48 VDC (Low Voltage) output cabinets.
3. Serial Interface Unit (SIU).
   The SIU shall be an EDI - Model 2218 or approved equal.
4. Auxiliary Display Unit (ADU).
   The ADU shall be an EDI - Model 2220 or approved equal.
5. Cabinet DC Power Supply (CPS).
   The CPS shall be an EDI – Model 2216 or approved equal for High Voltage Cabinets (120 VAC Output).
   An EDI – Model 2217 or approved equal may be utilized in smaller more compact cabinet configurations that do not require the power level of the EDI – Model 2216 power supply or do not utilize a 19-inch rack.
   The CPS shall be an EDI – Model 2248 or approved equal for Low Voltage Cabinets (48 VDC Output).
6. High-Density Flash Transfer Relay (HDFTR).
   The HDFTR shall be an Struthers-Dunn Model 21H or approved equal.
7. Main Contactor (MC).
   The MC for High Voltage Cabinets (120VAC Output) shall be a solid-state relay, Struthers-Dunn Model 428-AXXL-48VDC or approved equal. The MC for Low Voltage Cabinets (48VDC Output) shall be a solid state relay, Struthers-Dunn Model 429-AXXL-48VDC or approved equal.
8. Cabinet Suppressor-Filter.
   The cabinet shall be equipped with a Cabinet Suppressor–Filter, HESCO HE-1750R or approved equal.
9. HDSP Suppressor.
   The HDSP Suppressor shall be a HESCO HE103C-9 or approved equal.
10. Detection Module Suppressor.
    The Detection Module Suppressor shall be a HESCO HE6LC-6 or approved equal.

(o) Type ATC Controller Cabinet Assembly Configurations.

Termination Assemblies shall be installed on the back of the cabinet cage near the bottom of the cabinet. Input Termination Assemblies shall be installed below the Output Termination Assemblies. A Model 2216 or 2248 CPS, if utilized, shall be installed in the top U on the back of the cabinet cage. Bus Assemblies shall be installed on the back of the cabinet cage in the first available U's from the top.

1. Standard Large Base Mount
   Shall be Caltrans Cabinet Housing 1B (Approx. 67"H x 24"W x 30"D)
   Doors required 2 (1 front, 1 back)
   Base mount
   Requires 24 Detector inputs and 16 Channels output (Expandable to 72 detectors and 32 channels output as required)
   The ADU shall be installed in the top U of the cabinet. The next 3 U's shall be reserved for the controller unit. The 6 U's immediately below the controller shall be reserved for Input Assemblies. The drawer shall be installed below the space reserved for the Input Assemblies. The Output Assembly shall be installed in the first available U's beneath the drawer.
   All assemblies shall be mounted a minimum of 6" above the bottom of the cabinet.

2. Standard Pole Mount / Small Base Mount
   Shall be Caltrans Cabinet Housing 2 (Approx. 46”H x 24”W x 20”D)
   Doors required 2 (1 front, 1 back)
   Pedestal, pole, or base mount (Base mount will require a Type 332/336 Base Adaptor; Pole Mount will require a Cabinet Housing 2 Pedestal Adaptor)
   Pole mounts shall be located on the same side as the door hinge in such a manner that a technician can observe the signal and display of controller at the same time
   Requires 24 Detector Inputs and 16 Channels Output.
   The ADU shall be installed in the top U of the cabinet. The next 3 U’s shall be reserved for the controller unit. The 6 U’s immediately below the controller shall be reserved for Input Assemblies. The drawer shall be installed below the space reserved for the Input Assemblies. The Output Assembly shall be installed in the first available U’s beneath the drawer. The Service
   Assembly shall be installed at the bottom of the Cabinet Cage.

3. Compact
   Shall be approximately 25”H x 16”W x 17”D
   Doors required 1 (1 front)
   Pedestal or pole mount
   Pole mounts shall be located on the back or side in such a manner that a technician can observe the signal and display of controller at the same time.
   Deviations for compact cabinet from this specification:
   A single-point latch is allowed.
   The compact cabinet may have an alternative door handle but shall have a provision for padlocking.
   No drawer is required.
   Assemblies are not required to be 19-inch rack mountable.
   The input and output cards may share a combined Input/Output Assembly.
   The cabinet shall be capable of providing at a minimum the following combinations of input and output: 16 Detector Inputs/4 Channels Output, 12 Detector Inputs/6 Channels Output, and 8 Detector Inputs/8 Channels Output.
   No separate Serial Bus or Power Bus Assemblies are required. Only one spare clean AC NEMA 5-15R receptacle is required and one spare DC Power Phoenix connector is required. SB1/SB2 Connections may be limited to those required for a fully functional Controller Cabinet Assembly.
   Assemblies may be combined into more compact assemblies so long as overall Controller Cabinet Assembly function is preserved.
   Assemblies shall be hinged to allow access to termination facilities on the interior of the cabinet.
   Only termination facilities for the above listed combinations of inputs and outputs are required.

890.06 Controller Assembly Documentation.

1. Serial Number.

A serial number shall be engraved or stenciled on the cabinet. The serial number shall be the same number as the controller unit serial number.

2. Data Label.

A data label shall be placed on the inside of the cabinet door to provide the following information:

Manufacturer's name – All equipment installed cabinet
Date of Manufacture
Wiring Schematics Number
Controller Model Number
Controller Serial Number
Conflict Monitor Model Number
Conflict Monitor Serial Number
Time Clock Model Number (If applicable)
Time Clock Serial Number (If applicable)
Communication Device Model Numbers (If applicable)
Communication Device Serial Numbers (If applicable)
Project Number or Transportation Department P.O. Number.

3. Wiring Diagram.

One copy of the cabinet wiring diagram shall be supplied as well as a copy of the following:

Operations Manuals for all equipment
Base Mounting Template (if required)
Additional prints, diagrams, and manuals shall be available upon request at no additional charge.
Cabinet prints shall include flash color change instructions for all phases and all overlaps.
Cabinet prints shall be keyed to show every input and every output from every terminal.
If prints use multiple ground and neutral busses, busses shall be numbered. All grounds and neutrals shall be keyed to the busses that they are connected to.
Cabinet prints shall show every connector.

890.07 Remote Detection and Interconnect Protection.

Each remote detector input line and interconnect line, as it enters the cabinet shall be furnished with a surge protection device that meets or exceeds the following requirements.
Unit shall be capable of withstanding 10,000 A 10:20 microsecond standard waveform surges a minimum of 50 times.
Unit shall have internal follow-current limiters (resistive elements).
Unit shall self-extinguish within 8.3 milliseconds after the trailing edge of surge.
Unit shall not have thermal circuit breakers in place of limiters.
Limiter resistance shall be between 0.15 ¤ and 0.39 ¤.
Unit shall have a mounting plate for easy removal and replacement and shall be mounted in the controller cabinet in a neat workmanlike manner.

890.08 Vehicular Loop Detector.

(a) General.

Vehicle loop detector units shall be card rack units meeting the requirements of NEMA TS2-2016, latest version.

NEMA TS1 shelf mounted detectors may be used in existing NEMA TS1 cabinets if specified. NEMA TS1 detectors shall meet the latest NEMA TS1 standards.

890.09 Interconnect Cable.

(a) Description.

Interconnect cable shall be used to transmit information between intersections or other control points in a traffic control system.

(b) Materials.

Interconnect cable shall conform to the requirements of this specification unless otherwise specified on the plans or in the proposal. If in such case that the plans designate fiber optic cable material be used for the interconnect cable, then Section 729 shall apply.

(c) Underground Interconnect Cable.

Underground interconnect cable, for closed loop systems, shall be shielded and conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 39, filled telephone cable, No. 19 AWG, 6 pair.

Underground interconnect cable for time base coordination shall conform to the requirements of IMSA 20-1 No. 14 AWG, 9 conductors.

(d) Aerial Interconnect Cable.

Self-supporting aerial interconnect cable, for closed loop systems, shall be shielded and conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 38, No. 19 AWG, 6 pair.

Standard aerial interconnect cable, for closed loop systems, attached to a messenger strand in the field, shall conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 22, No. 19 AWG, 6 pair.

Self-supporting aerial interconnect cable, for time base coordination, shall conform to the requirements of IMSA 20-3, No. 14 AWG, 9 conductors.

Standard aerial interconnect cable, for time base coordination, attached to a messenger strand in the field, shall conform to the requirements of IMSA 20-1, No. 14 AWG, 9 conductors.

(e) Interconnect Cable Support Wire.

A support cable, whether separate or integral to aerial interconnect cable, having a minimum diameter of 0.25 inch {6.35 mm} shall be provided for interconnect cable that is not self-supporting.

Support cable shall be steel wire strand Class A (double galvanized) and conform to the requirements of ASTM Standards Publication No. A 475-89, "Standard Specifications for Zinc-Coated Wire Strand".

(f) Cable Attachment Hardware.

Attachment hardware shall be stainless steel or non-corrosive material and shall be provided with tensile strength adequate for application.

890.10 Electrical Power Service Assembly.

(a) Description.

Electrical power service assembly shall consist of equipment to provide a pole attached raceway and disconnect switch for use with power cable routed from the service entrance to the controller cabinet and nearest supporting structure with luminaire. The electrical power service assembly shall include a weatherhead, conduit and fittings, a disconnect switch with enclosure, and attachment clamps.

Electrical power service shall be in accordance with these specifications, NEC requirements, local utility codes, and on the details shown in the Special and Standard Highway Drawings.

(b) Materials.

Materials shall be tested and approved by a nationally recognized testing laboratory and shall meet the following requirements.

1.Service Pole (Wood Pole).

Service pole shall be southern yellow pine treated in accordance with the latest American Wood-Preserver's Association (AWPA) standards and shall conform with the requirements given in Section 833.

Unless otherwise noted on the plans, service pole used for service lateral drop shall be a 35 foot Class 3 wood pole and shall conform to the requirements of ANSI Standards Publication No. 05.1-1992, "American National Standards for Wood Poles – Specifications and Dimensions".

The poles shall not have more than 180 degrees of twist in grain over the full length and the sweep shall be no more than 4 inches {100 mm}.

2. Attachment Hardware.

Attachment hardware shall meet the requirements as shown on the details in the Special and Standard Highway Drawings.

3. Conduit.

Conduit shall conform to the requirements specified in this Section.

4. Weatherhead.

Weatherhead shall be made of a copper-free aluminum alloy or galvanized ferrous material.

5. Electrical Cable.

Phase or current carrying conductors shall be of the type RHH, RHW, USE, or XHHW. Conductors shall be stranded annealed copper with not less than 98 percent conductivity and shall be insulated for 600 V or more with rubber insulation and a neoprene jacket, or with cross-linked polyethylene insulation. The size of the conductor, voltage rating and type of insulation shall be clearly marked on the conductor in a color that contrasts with the color of the insulation.

Service wire to supply the controller shall be No. 6 AWG, stranded copper, two conductors rated for dry and wet conditions. The equipment grounding conductor shall be a bare conductor or shall be identified by a continuous green insulation. Grounded conductors (neutrals) shall be identified by a continuous white color insulation.

Service wire to supply the traffic signal luminaries shall be No. 8 AWG, stranded copper, three conductors rated for dry and wet conditions. The equipment and pole grounding conductor shall be a bare conductor or shall be identified by a continuous green insulation. Grounded conductors (neutrals) shall be identified by a continuous white color insulation.

6. Meter Base.

When a meter base is required, meter base shall be a meter base approved by the local electric power company.

7. Service Disconnect.

Enclosure Cabinet: The cabinet shall conform to NEMA standards, made of galvanized steel, aluminum, stainless steel or other material approved by the Engineer. The enclosure shall have a hinged door with a padlock. Padlock No. 3210 keyed for a No. 3 key shall be provided. One key shall be hung within the controller cabinet.

Circuit Breaker: A manually resettable circuit breaker shall be installed, which has a current rating of the circuit to which electrical power is provided.

Transient Protective Device: A surge lightning arrestor rated for a maximum permissible line to ground voltage of (175 V AC) shall be installed, meeting the requirements of NEMA standards for surge arrestors.

8. Photoelectric Control Units.

The photoelectric control shall meet the design and testing requirements of ANSI C136.10.

The photoelectric control unit shall also:

be a dusk-to-dawn sensor attached to the service pole or as specified by the plans;
have relay contacts that are single-pole, single-throw (SPST), normally closed (NC);
contain built-in surge and lightning protection;
have a direct load rating of 1000 Watts incandescent load and 1800 volt-amperes for High Pressure Sodium;
have a rated life at full load of at least 5,000 on-off operations.
upon failure leave the luminaires turned on as a notification of needed maintenance;
be able to operate over the range of 105-130V, 60 Hz. AC (120 V Nominal);
have over voltage protection for the control components and the load circuit by the means of an expulsion type surge arrester capable of passing the surge outlined in ANSI C136.10;
be calibrated for a "Turn-on" setting of 2.6 footcandles and a "Turn-off" setting not exceeding 0.6 times the "Turn-on" setting;
have a control housing that is UV resistant.

The photoelectric control shall have a cadium-sulfide light sensitive element. The base shall have an integral, locking type, brass 3 prong plug according to NEMA SH16-1962 and a neoprene gasket that meets IEEE/NEMA publications.

Photoelectric control units shall be installed facing north; however, if obstructions are such that this is not possible then they shall be installed facing south.

890.11 Uninterruptable Power Supply Systems.

(a) General.

Uninterruptable Power Supply/Battery Backup Systems are to be used at intersections utilizing only LED indications. For intersection traffic control, there are two types of systems: On-line and Line-interactive.

On-line systems use a “double conversion” method that converts/rectifies the AC input to DC power, passes power through the power bank, then converts/inverts power back to AC for the use by the equipment. In this method, the batteries are in constant use, thus requiring a method to swap-out bad batteries without shutting down the system and the equipment it supplies power to.

Line-interactive systems (battery backup/standby UPS) pass power through an inverter/converter type device utilizing the line power as the primary power source for the equipment, leaving the battery bank as the secondary power source and charging or maintaining the charge of the battery bank. Some filtering of the line power is accomplished through this system. Should the line power fail, the battery bank will activate, becoming the primary power source for the equipment.

(b) Cabinet.

1. Convenience Receptacle. One 15 A GFI duplex outlet shall be provided inside the cabinet.

(c) Physical Requirements.

1. Firmware.

System Firmware shall be included for the operational needs of the system. The user/operator shall be able to access the system, without requiring any additional equipment, to adjust system parameters and read logged events.

The system firmware shall be upgradeable via a USB or local area network RJ 45 port.

2. Display.

The unit inside the cabinet shall contain a display showing the status of the unit. The following is a minimum data set to display:

- Battery status or charge status
- Current operation of system (on or off battery if line-interactive system)
- AC line output voltage and current draw
- AC line input voltage
- Power status (system on or off)

3. Temperature.

The UPS shall be capable of operating in the temperature range of -29°F to +165°F {-34°C to +74°C}.

4. Communication.

The UPS shall be capable of using a USB and/or an Ethernet port (RJ45) for local control using a laptop PC or through a remote connection via modem or Ethernet.

5. Battery Bank.

The battery bank shall be comprised of one or two types of systems; unmanaged or managed.

An unmanaged battery bank will generally consist of standard automotive/marine type batteries that do not monitor or control the charge/discharge of the battery. Typical types of batteries are flooded cell, VRLA, AGM, etc.

A managed battery bank will generally consist of some sort of small battery pack that has internal electronics in the pack to manage the charge/discharge of the battery. This type of battery bank is maintenance free.

a) Unmanaged.

The battery terminals shall have a protective covering on them to prevent accidental spark or shorting.

The batteries used shall utilize either bolt insert stud terminals or flag terminals. “Keyed” pigtail connection cables shall be provided with 5/16 inch {8 mm} stud sized ring/lug thermals to connect to the batteries.

The system shall have a full battery management system that includes active or equalized balancing as well as temperature, voltage, and amperage of charge or

discharge monitoring to maximize the life of the batteries.
Battery harness connections, between the controller and the batteries, shall be made through the use of “keyed” connectors to prevent shorting and for the ease of battery replacement. The harness shall allow for the battery bank or batteries to be quickly and easily connected in order and keyed to ensure proper polarity without the need for any special tools. Each battery bank or battery shall contain a fuse or breaker, sized to protect the system against shorting or battery failure.

b) Managed.
The battery bank shall include a protective connection system to prevent accidental spark or shorting.
The battery bank shall internally control, monitor, and balance temperature, voltage, and amperage of charge/discharge, providing maintenance-free operation for a minimum of five (5) years.
The battery bank harness connections between the UPS and the battery bank shall be made with military connectors or similar barrel connectors to ensure easy replacement and prevent shorting, battery failure, and ensure polarity is proper without the need for any special tools.
The battery bank shall be capable of being charged via a 120 VAC charging device.

(d) Physical Requirements.

Unit shall be compatible with traffic signal electronics. The unit shall be able to run a traffic signal cabinet in battery back-up mode with no operational issues initiated by the unit.

The system shall be equipped with a manual bypass switch (normal/bypass minimum) that will not interrupt power to the controller. The “Normal” position shall indicate that the system is in operation. The “Bypass” position shall indicate that the line power is not coming into the system, system off-line, allowing for maintenance and testing of the system without interfering with the operation of the signal equipment.

The transfer from utility power to battery power, and vice versa, shall not interfere with the normal operation of the traffic signal controller, conflict monitor, or any other peripheral devices within the traffic signal controller assembly.

Shall provide a minimum of 1400VA, 1000 watts peak load at 120°F {49°C}

Shall has an output voltage of 120 VAC, 60 Hz ±3 Hz, < 5% THD.

Shall provide a method of sending a signal or information to the signal controller to alter the operation of the signal from normal mode to flashing operation based on conditions in the system to extend the operation of the signalized intersection. The system shall also be capable of transmitting this information to the use/agency to advice of the change in signal operation.

The system shall maintain an event log of the last 1000 events. The log file shall be in a standard ASCII text format. This log shall contain, at a minimum, the following items:

- Date and Time of event
- Type of event
- Duration of event
- Battery status
- Input line voltage status

The system shall be equipped with lightning surge protection compliant with IEEE/ANSI C.62.41 latest edition and meet all current UL1449 standards. The lightning surge protection shall be provided to the utility line voltage coming into the system.

Shall be capable of producing a fully regenerated, conditioned, pure 120 VAC sine wave output at all times within a voltage input range of 85 VAC to 145 VAC. This output shall be maintained regardless of the battery state.

Shall be capable of operating, with no loss in output quality, while having the input power supplied by a generator.

The system shall be able to operate at 120% of the load capacity of the system for a minimum of 60 seconds before transferring to direct line-in power. Shall maintain the direct line-in power until the overload condition has been cleared for a minimum of 30 seconds.

There shall be no change in operation should loss of utility power occur. The system shall continue to provide AC power until the batteries are depleted or power is restored.

Restoration of line power, after depletion of the batteries, shall cause the system to resume conditioned power operations without user assistance.

The system shall be capable of starting-up, providing power without the presence of the input line power.

Should the inverter/condition fail in the system, the input line power shall be transferred directly to the output of the system.

The system shall run a self-diagnostic upon start-up and be capable of running a diagnostic, from the front panel, while the system is running without any effect on the system operation.

The front panel of the system shall display, at a minimum, the following conditions:

- AC line status
- UPS battery status (charging, percent charged, etc.)
- System faults
- System Bypass status
- Load capacity/status

1. On-Line Systems

The system shall provide, at a minimum, 3 contact closures. One of these shall indicate "Inverter Failure". The others shall be user programmable as required,

The system shall provide an automatic power transfer to live power upon inverter/system failure.

2. Line-Interactive Systems

The system shall provide, at a minimum, 3 contact closures. One of these shall indicate "UPS on Batteries". The others shall be user programmable as required.

The system shall automatically transfer to line power if the output load exceeds 150% of the design load for more than 5 seconds. This transfer shall stay in effect until the load has been cleared for more than 30 seconds.

The system shall have the capability of bypassing the utility line voltage whenever the utility line voltage is outside of the manufacturer's default or user-programmed voltage range by ±2VAC.

(e) Testing/Acceptance Requirements.

Shall be capable of running a minimum of 5 hours based on the following conditions:

- 8-phase cabinet, controller & malfunction management unit set on a 90 second cycle
- 10 – 3-section, 12", LED ball signal heads
- 2 – 16", pedestrian heads
- No detectors

(f) Documentation/Warranty Requirements.

A minimum of two (2) sets of operational and maintenance manuals shall be provided with the system. This shall cover all aspects of the system from the installation to general/special maintenance issues. Also two (2) sets of cabinet wiring schematics depicting locations of each component and electrical interconnection drawings. One (1) of the required copies can be furnished in digital format.

The following shall be provided by the manufacturer:

- Model & Serial numbers shall be visible on all electrical components
- Power and current requirements
- Temperature range
- Weight and dimensions

- Required mounting equipment
- Response time and sensitivity
- Required software
- Manufacturer's recommended capabilities
- Any limitations, requirements, or potential hazards associated with the operation of maintenance of the device.

All product documentation shall be written in the English Language.

The UPS system shall be warranted to be free of defects in material and workmanship for a period of **THREE YEARS** from the date of installation. During the warranty period, the supplier shall repair with new materials or replace at no charge any product containing a warranty defect. All materials returned from warranty repairs shall be made through the product distributor at no additional charge. Warranty repairs/replacement shall not exceed two weeks from date of return to the distributors.

890.12 Span Wire Assembly.

(a) Description.

Messenger cable shall be attached to supporting structures to support traffic signal heads, signs, and electrical cables.

(b) Materials.

1. Steel Wire Strand.

   Steel wire strand shall be Class A (double galvanized) and shall conform to the requirements of ASTM A 475-89.

2. Messenger Cable.

   Messenger cable used to support signal heads shall be 3/8 inch {9.5 mm} nominal diameter, 7 wires twisted into a single strand.

   Messenger cable shall be extra high-strength grade with a minimum breaking strength of 15,400 pounds {68.4 kN}.

3. Tether Cable.

   Tether cable attached to the bottom of signal heads shall be 1/4 inch {6.4 mm} nominal diameter, 3 wires twisted into a single strand.

   Tether cable shall be utilities grade with a minimum breaking strength of 3,150 pounds {14.0 kN}.

890.13 Vehicular Signal Heads.

(a) ITE Standard Publications.

Traffic signal heads and LED modules shall conform to the latest applicable ITE standards and specifications for Vehicle Traffic Control Signal Heads (VTCSH).

48VDC LED signal indications shall meet ITE requirements for color and intensity and shall meet any future requirements applicable to 48 VDC indications.

Traffic signal heads shall be assembled and mounted per the MUTCD.

(b) Separate Illumination.

Each lens of a signal head shall be illuminated by a separate LED Module.

(c) Housing, Door, and Visor.

Shall be cast aluminum alloy, unless otherwise specified. Materials shall meet ITE VTCSH specifications.

(d) Trunnions, Brackets, and Suspensions.

All trunnions, brackets, and suspensions used for assembling and mounting vehicle traffic control signal faces shall be entirely weather-tight.

Wire entrance fittings for signal heads and span wire hangers shall be cast aluminum tri-stud with aluminum span wire hinge with stainless steel nuts, bolts, and washers.

Wire raceway areas within brackets, trunnions and suspensions shall be of adequate size to carry all necessary wires without crowding, and raceway surfaces shall be free of sharp edges or protrusions that might damage insulation on wires.

Suspensions for mast arm or span wire mounting shall include a device to permit adjustment for proper vertical alignment of the signal head.

(e) Exterior Finish.

All exterior parts of the signal head except the lens, the insides of visors, and the entire surface of louvers or fins shall be finished of the best quality of synthetic resin enamel that is colored black or federal highway yellow. A combination color scheme may be used in lieu of either an all-black or an all-federal highway yellow. A combination color scheme may consist of an all-black face with an all-federal highway yellow body. No other combination color schemes or the mixing of allowed color schemes shall be used within an intersection or project unless noted otherwise on the plans.

The inside of the visors and the entire surface of louvers or fins shall be painted dull black.

The exterior finish shall satisfy the latest ITE VTCSH specifications.

(f) Back Plates.

Backplates shall be installed as shown on the plans. Backplates shall have a 5 inch {127 mm} border constructed of black metal with a 2 inch {51 mm} fluorescent yellow retroreflective material applied to the front of the backplate along its outer border.

(g) Signal Head Cover.

Signal head covers shall be opaque, black, and cover the signal head. The cover shall be weather and ultraviolet resistant. A garden or trash bag shall not be an acceptable cover. The cover shall be so designed so that it will not collect/hold water in the bottom of the cover.

The Contractor shall submit the proposed cover and method of attaching the cover over the signal head to the Engineer for approval.

(h) Programmed Vehicular Signal Head.

Programmed vehicular signal heads shall utilize an LED light source. They shall meet the requirements of the latest ITE VTCSH specifications. Exceptions shall be made for electrical mating requirements. The signal head shall have a means to limit visibility of projected light. The signal head shall be capable of limiting visibility of the signal indication to the parameters specified in the plans.

Programmed vehicular signal heads shall be internally optically programed or shall utilize electronic steerable beam or other similar technology to provide the required zone of visibility.

Louvers or other devices placed within the visor to limit visibility shall not be used, unless specified in the plans.

1. Lamps.

Lamps used in traffic signal heads shall conform to the standards set forth in the ITE latest Standard for Traffic Signal Lamps, not smaller than 125 V, 8000+ hour rated life clear bulb in accordance with the following:

12 inch	{300 mm}	Red lens	150 or 165 W	3 inch light center length
12 inch	{300 mm}	Yellow lens	69 W	3 inch light center length
12 inch	{300 mm}	Green lens	116 W	3 inch light center length

2. Wiring.

Each lamp receptacle shall be provided with coded No. 18 AWG {1.06 mm} or larger wires type TEW, 600 V, securely fastened to the socket.

A suitable terminal block for connection of the wires from the socket and the incoming wires to the traffic signal head shall be provided in the signal housing.

3. Reflectors.

Reflectors shall be specular Alzak finished aluminum or an approved equal.

Reflectors shall be mounted in a cast aluminum reflector support attached to the housing, or shall be an integral reflector and support of formed sheet aluminum.

The reflector assembly shall be pivoted to the housing, and shall be designed so that it can be swung out or easily removed without the use of any tools.

The method of mounting and fastening reflectors shall be sufficiently rigid to secure proper alignment between the lens and reflector when the door is closed.

The construction of the signal head and its components shall be such that the fit between the reflector and the lens will eliminate all possibility of false indicators.

Reflectors shall have an opening in the back for the lamp socket.

4. Lenses.

Lenses shall be of glass; the quality and processing of which shall be the best for the purpose. The composition must be durable on prolonged exposure to weather; all lenses shall be

uniformly colored throughout the body, true to size and form, and free from any streaks, wrinkles, chips, or bubbles that in any way detract from their efficiency or use.

Each lens shall have pressed on its flange the word "TOP" to indicate the proper positioning of the lens in the door for obtaining the light distribution required, together with the diameter and other designations including the name or trademark of the manufacturer needed for proper application and help in purchasing replacements.

A nominal 12 inch {300 mm} circular convex lens shall have an outside diameter of from 11.938 inches to 12.031 inches {303 mm to 306 mm}.

A nominal 9 inch {225 mm} rectangular lens shall have minimum over-all dimensions of 9 inches by 8.75 inches {228 mm by 222 mm}.

A nominal 12 inch {300 mm} rectangular lens shall have minimum over-all dimensions of 12 inches by 12 inches {305 mm by 305 mm}.

All lenses shall comply with the design designated by ITE for the use intended.

The color of the lens shall be of a color approved for use by ITE for the use shown on the plans.

(i) LED Modules.

1. General Requirements.

Shall meet the latest ITE VTCSH Specifications.

Shall satisfy the optional VTCSH requirements for failed state impedance.

Aluminum-Gallium-Arsenic (ALGaS) LED technology shall not be use; other LED technology less susceptible to temperature degradation shall be used.

2. 120VAC LED Modules.

Shall be operationally compatible with NEMA TS1 & TS2, Type 170 & 2070 controllers, and ATC controllers, conflict monitors with plus features, malfunction management units, and cabinet monitor units (CMUs) currently used by the Alabama Department of Transportation and any other State government entities.

3. 48VDC LED Modules.

Shall be operationally compatible with low voltage ITS cabinets and CMUs.

Round indications shall operate at a maximum typical wattage of 5.0 Watts or less at 25 degrees Celsius for red, 9.0 Watts or less for yellow, and 7.0 Watts or less for green indications.

Arrow indications shall operate at a maximum typical wattage of 4.0 Watts or less at 25 degrees Celsius for red, 7.5 Watts or less for yellow, and 5.0 Watts or less for green indications. Arrow Indications shall operate at any orientation in the signal head.

Minimum wattage for 48VDC LED modules shall be 2.0 Watts unless otherwise specified by ITE.

4. Warranty Requirements.

All LED traffic signal lamp units shall be warranted against failure due to workmanship and material defects during the first 60 months of field operation. The LED signal lamp units shall also be warranted to meet or exceed the minimum luminous intensity values during the first 60 months of operation. This warranty shall be included with each LED signal module, in writing, by the manufacturer. The warranty shall include a commitment by the manufacturer to replace all failed LEDs at no cost the Department.

(l) Lenses for LEDs.

The lens for an LED signal lamp unit shall be a UV stabilized polymeric lens that is sealed to the LED housing to prevent dust and moisture from entering the unit.

(m) LEDs for Replacing Lamps in Existing Incandescent Signal Heads.

The LED traffic signal lamp unit shall be designed as a retrofit replacement for existing signal lamps, which will not require any special tools for installation. The 12" retrofit replacement LED traffic signal lamp unit shall fit into existing traffic signal housings without modifications to the housing.

Installation of a retrofit replacement LED traffic signal lamp unit into an existing signal housing shall only require removing the existing lens and incandescent lamp, fitting of the new unit securely in the dousing door, and connecting the unit to existing electrical wiring or terminal block by means of simple connectors. The LED retrofit shall not require the removal of the reflector.

If proper orientation of the LED unit is required for optimal performance, prominent and permanent directional markings (an "UP arrow") for correct indexing and orientation shall exist on the unit.

The manufacturer's name, serial number, model number, manufactured date, and other necessary identification shall be permanently marked on the backside of the LED traffic signal lamp unit. A label shall be placed on the unit certifying compliance to ITE standards.

The LED traffic signal lamp unit shall be a single, self-contained device, not requiring on-site assembly for installation into an existing incandescent traffic signal housing.

(n) Submittal Data Required for LEDs.

Each LED traffic signal lamp unit shall be provided with the following data:

Complete and accurate installation wiring guide;

Contact name, address, and telephone for the representative, manufacturer, or distributor for warranty repair;

Schematics for all electronics.

The Contractor shall submit a copy of a test report certified by an independent laboratory that the LED traffic signal lamp model submitted meets ITE Standard for light distribution, chromaticity, and power (consumption, power factor, and harmonic distortion). In addition, the independent lab report shall specify the drive current being supplied to individual LEDs within the unit. Designs which require LEDs to be operated

(o) Bi-Modal Signal Head.

Shall contain a bi-modal LED module. A bi-modal LED module shall have separate yellow and green circuits or yellow and yellow circuits. The bi-modal module shall meet the latest applicable ITE VTCSH specifications. The indications shall only be used for flashing yellow arrow assemblies.

The signal head shall be constructed in accordance with the requirements of the MUTCD.

890.14 Pedestrian Signal Heads.

(a) General.

All pedestrian signal heads shall conform to the latest requirements of the ITE Pedestrian Traffic Control Signal Indicators (PTCSI) specification and be assembled in accordance with the latest edition of the MUTCD.

(b) LED Pedestrian Signals.

120 VAC Light Emitting Diode (LED) pedestrian signal heads shall conform to all applicable ITE standards and specifications for LED pedestrian traffic signals.

48 VDC LED pedestrian signal modules shall meet ITE requirements for color and intensity and shall meet any future requirements applicable to 48 VDC indications.

48 VDC LED pedestrian signal modules shall operate at a maximum typical wattage at 25 degrees Celsius of 8.0 Watts for the Portland Orange hand, 7.0 Watts for the Lunar White man, and 5.5 Watts for the Portland Orange countdown.

Pedestrian signal heads shall be assembled and mounted per the latest edition of the MUTCD.

890.15 Pedestrian Detectors.

(a) General.

Pedestrian detectors shall conform to the American with Disabilities Act Accessibility Guidelines, Section 14.2.5(1) "Crossing Controls", dated 1994.

(b) Materials.

Pedestrian detector shall be capable of actuation by a force equal to or less than 5-pound force {22.2N}.

A control button shall be raised or flush and shall be a minimum of 2 inches {50.8 mm}.

The microswitch shall be dustproof, water-resistant type.

The splice between the cable and the detector leads shall be waterproof.

The pipe or other protective cable covering to the detector housing shall be secure.

The detector shall be provided with a housing to prevent the entrance of water.

Where a push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a push button is to be mounted on top of a post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

(c) Hardware.

Hardware and fittings shall be constructed of galvanized steel or non-corrosive metal.

890.16 Signal Cable.

(a) Description.

Signal cable shall be used to supply electrical power to vehicle and pedestrian signal heads, lane control signals, electrically powered signs, and pedestrian detectors.

(b) Materials.

Signal cable shall conform to the requirements of IMSA Specification No. 20-1, polyethylene insulated, polyethylene jacketed communication cable.

Unless otherwise noted on the plans, signal cable conductors shall be stranded copper, No. 14 AWG. The number of conductors shall be provided as follows:

890.17 Loop Detector Wire.

(a) Description.

Loop detector wire shall be used to provide a zone of detection (sensor loop) where the passage or presence of a vehicle in the zone causes a decrease in the inductance of the loop.

(b) Materials.

1. Wire.

Wire shall be Type USE-2, Type RHH, or Type RHW-2 XLP, 600 V cross-link polyethylene insulated cable. All loop wire shall have an insulation thickness of 0.045" (45 mils).

Wire shall be No. 12AWG.

Wire shall have a stranded conductor of 7-10 strands that is soft annealed stranded wire of not less than 98 percent conductivity.

The outer jacket shall be surface printed indicating the manufacturer, national research testing laboratory listing, maximum rated voltage, AWG size, the proper type letter or letters for the type of wire or the IMSA specification number every two feet {0.6 m} or less.

Preformed loops that are listed on the MWSAR may be used.

2. Loop Sealant.

Proposed loop sealant shall be included in the proposed material submittal as required in Section 730.

890.18 Loop Detector Lead-In Cable.

(a) Description.

Loop detector lead-in cable shall be used to connect the sensor loop to the input termination panel.

(b) Materials.

Loop detector lead-in cable shall conform to the requirements of IMSA Specification No. 50-2, polyethylene insulated, polyethylene jacketed shielded, loop detector lead-in cable.

The cable shall have stranded tinned copper conductors, No. 12 AWG.

The cable shall have two conductors individually insulated in a twisted pair configuration.

The cables shall be spliced with a 2-part epoxy underground power splice kit.

890.19 Junction Box.

(a) Description.

Junction box shall be provided to splice loop wires to shielded lead-in-cable, to allow access to ground rods located beneath sidewalks, and to decrease friction drag of pulling underground cable through conduit.

(b) Materials.

1. Junction Box.

Shall be capable of withstanding a vertical load test of 20,000 pounds {9.07 metric tons} over a 10 inch {254 mm} by 10 inch {254 mm} area. Junction boxes located within a roadway, sidewalk, or concrete island shall be of polymer concrete construction. Junction boxes located elsewhere may be constructed of HDPE or fiberglass, unless otherwise specified. Regardless of the construction, all junction boxes shall satisfy the load testing requirements. On a given project, boxes located in roadways, sidewalks, and concrete islands shall be of the same construction and be from the same manufacturer; likewise, junction boxes used elsewhere on the project shall all be of the same construction (HDPE or fiberglass) and come from the same manufacturer.

Junction box shall conform to the dimensions shown on the details in the Special and Standard Highway Drawings.

2. Junction Box Cover.

All junction boxes shall be supplied with a heavy-duty cover tested to 20,000 pounds {9.07 metric tons} over a 10 inch {254 mm} by 10 inch {254 mm} area. Covers located within a roadway, sidewalk, or concrete island shall be of polymer concrete or metal construction. Covers located elsewhere may be constructed of a composite material, unless otherwise specified. Regardless of the construction, all lids shall satisfy the load testing requirements. On a given project, covers located in roadways, sidewalk, and concrete islands shall be of the same construction and be from the same manufacturer; likewise, covers used elsewhere on the project shall all be of the same construction and come from the same manufacturer. The junction box shall have a locking cover. The junction box cover shall be embossed with "TRAFFIC SIGNALS" in standard block type not less than 1.5 inches {38.1 mm} in height.

890.20 Conduit.

(a) Description.

Conduit furnished shall be metallic or non-metallic, of the size specified on the plans.

(b) Rigid Metal Conduit (RMC).

Rigid metal conduit, couplings, and fittings shall be galvanized steel, meeting the requirements given in UL 6. Couplings and fittings shall be threaded.

(c) Rigid Nonmetallic Conduit (RNC).

Rigid nonmetallic conduit shall be Schedule 40 or Schedule 80 PVC and shall meet the requirements given in UL 651.

(d) Liquid-tight Flexible Metal Conduit (LFMC).

Liquid-tight flexible metal conduit shall meet the requirements given in UL 360. The thermoplastic covering shall be oil resistant. Connectors shall be either angle or straight and be UL listed for the intended use. LFMC shall be installed where conduits cross an expansion or open joint on bridges, barrier rails and other structures and shall be installed at other expansion locations as directed by the Engineer. The LFMC shall be a maximum of 36 inches {1800 mm} long and shall not sag more than 3 inches {150 mm} between the fixed ends of the rigid conduit.

(e) Liquid-tight Flexible Non-Metallic Conduit (LFNC).

Liquid-tight flexible non-metallic conduit shall meet the requirements given in UL 1660.

890.21 Supporting Structures.

(a) General.

Supporting structures (metal traffic signal pole, prestressed concrete traffic signal pole, mast arm pole, and pedestal pole) used for mounting signal equipment shall conform to the requirements of Section 718 and Section 891.

(b) Metal and Concrete Supporting Structure Features.

Handholes with covers shall be provided to facilitate installation and wiring.

Adapter with provisions for overhead wiring and wire entrance shall be provided for the top of the pole.

A grounding connection shall be provided adjoining the base.

When painting of the supporting structure is specified by the plans or proposal, the supporting structure shall have two primer coats applied at the factory or point of fabrication and two additional coats of high-grade exterior grade enamel applied in the field.

Paints shall conform to the applicable portions of Section 855.

(c) Timber Poles.

Timber poles shall be southern yellow pine treated in accordance with the latest American Wood-Preserver's Association (AWPA) standards and conform to the requirements of Section 833.

Unless otherwise noted on the plans, timber poles used for supporting traffic signals shall be Class 5 and shall conform to the requirements of ANSI Standards Publication No. 05.1-1992. The poles shall not have more than 180 degrees of twist in grain over the full length and the sweep shall be no more than 4 inches {100 mm}.

When required, guy wires shall be provided of adequate strength and shall meet the requirements of ASTM A 475-89. Guy wire anchors shall be expanding or screw type with a minimum guy tension of 8000 pounds {35 kN}.

890.22 Luminaire Extension Assembly.

(a) Description.

Luminaire extension assembly shall consist of an extension arm and a LED luminaire. The luminaire assembly shall conform to the requirements of this specification, unless otherwise specified on the plans, in the proposal, and on the details in the Special and Standard Highway Drawings.

(b) General.

The luminaire shall be of the horizontal type for IES Type III medium cutoff, distributing an asymmetrical light pattern.

(c) Materials.

1. Luminaire Extension Arm.

Unless otherwise shown on the plans, the extension arm shall be 12 feet {3.7 m} in length. Stud mounting bolts and brackets shall be provided.

(a) Photoelectric Control Unit.

A photoelectric control unit shall be provided and conform to the requirements of the Institute of Electrical and Electronic Engineers (IEEE) and NEMA.

(b) LED Luminaire.

LED Luminaires shall meet the requirements of Section 889 and the plans.

890.23 Concrete Foundations.

All concrete foundations or footings shall conform to the requirements of Section 718.

890.24 Signs.

The R10-12 sign, R10-4B sign, and any sign indicated on the plans as a part of the signal installation shall conform to the requirements of Section 880.

890.25 Video Detection System.

(a) Camera.

The camera enclosure shall have the following features and functionality:

Provide real time detection;

Operate from 0% to 100% humidity;

Include a lens with an automatic iris;

Be easily field replaceable;

Shall be clearly identified with the focal length and aperture;

Shall be resistant to vibration and resistant to shock when installed for operation.

(b) Camera Enclosure.

The camera enclosure shall have the following features and functionality:

Shall be a NEMA Type 4 enclosure;

Shall be fabricated from corrosion resistant aluminum;
Shall be finished in a light-colored UV and weather resistant paint;
Shall be provided with a sunshield;
Shall have a sunshield shall be designed to divert water flow to the sides of the sunshield.

(c) Camera and Enclosure Assembly.

The camera in the enclosure shall have the following features and functionality:

Shall have a heater mounted toward the front of the enclosure;

Weight of all components shall not exceed 10 pounds {4,54 kg}.

All devices required for maintaining the internal temperature and faceplate temperature shall be integral to the environmental enclosure. The heater shall not interfere with the operation of camera electronics and shall not cause interference with the video signal.

The weight shall include the environmental enclosure, complete with camera, fittings, heater, and transformers.

(d) Camera Mounting Assembly.

The camera mounting assembly shall have the following features:

Shall have all stainless steel or aluminum construction;
Shall meet the support requirements of the camera manufacturer;
Shall be equipped with lightening lightning protection;
Connections shall be mounted on the rear of the enclosure;
All connections shall have liquid tight fittings.

(e) Processor.

The processor shall be rack or shelf mounted in a controller cabinet and shall have a RS232 serial port.

The processor shall provide video output (BNC) for connecting a television monitor for testing purposes and for connection to video transmitter provided by others. The video output (BNC) shall be located at the front of the processor.

The processor shall be plugged into a NEMA-5-15R receptacle located in the controller cabinet.

The processor shall be capable of detecting vehicle presence in 8 user-defined detection zones. When the vehicle is in the detection zone, the detection zone shall change color or intensify on the screen to verify proper operation of the detection system.

(f) Video Interface Panel and Cables.

The video interface panel shall provide facilities to protect against damage from lightning.

Coaxial cable and power cable shall meet the requirements of vehicle detection manufacturer.

(g) Two Channel and Four Channel Detector Unit.

All detector units shall be compatible with Detector Rack Configuration 2 as described in NEMA TS2-2016, latest version.

890.26 Priority Control System, Traffic Signal Preemption.

(a) Priority Control Systems.

The priority control system shall be either acoustically (sound) activated, optically activated, or GPS (Global Positioning System) activated. All equipment and components shall meet or exceed all NEMA TS1 and TS2, as well as, Type 170, Type 2070 and ATC and ITS weather exposure durability requirements.

(b) Operational Requirements.

The priority control system shall be capable of providing preemption information to NEMA TS1, NEMA TS2, Type 170, Type 2070, and ATC traffic controllers used by the ALDOT. The priority control system shall be capable of setting time limits for how long a call can be held, when the call is dropped after a vehicle passes, or if the call is lost.

Acoustically activated systems shall be able to detect and respond to a preemption call from an emergency or priority vehicle at a minimum of 1000 feet {300 meters} from a roadway intersection. All other systems shall be able to detect and respond to a preemption call from an emergency or priority vehicle at a minimum of 2500 feet {760 meters} from a roadway intersection.

Setup and programming of the priority control system shall be accomplished using current ALDOT computer operating software.

(c) Log File.

The priority control system shall maintain a log file of at least 2000 of the most recent priority calls. This log file shall be downloadable in a standard ASCII, delimited format.

Each call record for all systems shall contain the following four items:

Time & Date: shall indicate the time and date the call was made;
Direction: indicates the direction from which the call was made;
ID: identifies what vehicle or device made the request;
Duration: indicates the total amount of time the call was active.

The following are additional requirements for optical and GPS activated systems:

User: department or agency that used the system;
Level: priority level used.

(d) Software.

The manufacturer's software shall be provided for the operation of the system. One software package shall be provided for each detection system. Software updates and revisions shall be provided to the ALDOT as updated by the manufacturer at no additional cost. The software shall not require a licensing fee.

All setup, controller program, and diagnostic software shall be provided and shall run on Microsoft Windows based operating systems. Software updates shall be provided free of charge.

On-line help screens shall be provided as an integral part of the system software. Interface software shall be capable of real-time viewing of the system activity.

(e) Documentation Requirements.

A minimum of 2 sets of operational and maintenance manuals shall be provided with the system. These manuals shall cover all aspects of the system from the installation to maintenance.

The following data shall also be provided by the manufacturer:

Model & Serial numbers shall be visible on all electrical components;
Power and current requirements;
Acceptable operational temperature ranges;
Weight and dimensions;
Required mounting equipment;
Operating frequency where needed;
Detection range;
Response time and sensitivity;
Required software;
Manufacturer's advertised product capabilities;
Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

(f) Warranty.

Final payment will not be made until a written warranty is provided by the Contractor and accepted by the Engineer in writing. The warranty shall be a written guarantee from the distributor or manufacturer that the priority control system will be fully functional and will remain free of defects in material and workmanship for a period of one year from date of acceptance. During the warranty period, the distributor or manufacturer shall repair with new materials, or replace at no charge, any device, product, or other material containing a warranty defect. All warranty repairs shall be made through the distributor or manufacturer at no additional charge. Warranty repair or replacement parts shall be provided within two weeks from date of return to the distributor or manufacturer.

The warranty will not begin until the traffic signal installation "30-day operational check period" is complete.

SECTION 891
STRUCTURAL MATERIALS FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING

891.01 General.

All materials used in the fabrication of overhead roadway sign, traffic signal, luminaire and traffic surveillance structural supports shall meet the requirements of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2009 Edition* (hereinafter referred to as the AASHTO Sign Specifications*)*. AASHTO material specifications shall govern in lieu of ASTM material specifications when an AASHTO equivalent specification exists for all references within any referenced specification.

891.02 Steel.

(a) General.

All grades of steel listed in the AASHTO *Standard Specifications for Highway Bridges* are applicable for welded structural supports for overhead roadway signs, luminaries, traffic signals and traffic surveillance and shall have a specified yield strength not less than 35 ksi {241 MPa}, unless otherwise specified on the contract plans, or within this Section. The specifications for steels other than ASTM and AASHTO shall be submitted to the Bridge Engineer for approval, prior to design. The contractor shall supply the Bridge Engineer with a copy of the steel specification corresponding to the steel that is being used if the steel is not covered by ASTM or AASHTO specifications.

(b) Fabrication.

Within 30 days after the award of the contract, the Contractor shall notify the Bridge Engineer in writing of the name and address of the fabricator of the structural steel. The notification shall include the fabricator's proposed fabrication schedule. Evidence of the fabricator's qualifications and experience shall be furnished if requested by the Bridge Engineer.

No material shall be fabricated before the Department has been notified where the fabrication order has been placed and the shop drawings have been reviewed and approved for distribution. The Fabricator is responsible for notifying the Bridge Engineer of any fabrication work to be done outside of their facility, the name and address of the outside fabricator, and the proposed fabrication schedule.

The Fabricator of the structures shall give the Bridge Engineer at least 30 days notice by submittal of a BBF-11 Form (Notice of Intent to Begin Fabrication) prior to the beginning of fabrication to allow time for arrangements to be made for an ALDOT inspector to be present during fabrication.

All steel structures shall be fabricated in a plant certified by the American Institute for Steel Construction for “Standard for Bridge and Highway Metal Component Manufactures (CPT)”.

Welding of steel members shall be in accordance with the AWS D1.1/D1.1M: 2015 Structural Welding Code—Steel 23rd Edition (hereinafter referred to as the AWS Structural Welding Code). Welders shall be certified in accordance with the AWS Structural Welding Code. All welds shall be visually inspected and be free of cracking and undercutting. High Mast lighting assembly pole to base plate welds shall be magnetic particle or ultrasonically tested. Circumferential butt welds shall not be allowed on overhead roadway sign structure uprights. All circumferential welds on steel poles shall be tested by ultrasonic for wall thickness of 5/16 inch {8 mm} or greater, or radiographic testing for wall thickness less than of 5/16 inch {8 mm}. All requirements of Section 1.4.2 of the AASHTO Sign Specifications shall be observed when welding and testing the poles. The longitudinal weld on the female section of lap splices shall be either one hundred percent full penetration, with quality assurance by ultrasonic inspection per the AWS Structural Welding Code, or shall be reinforced externally to ensure the development the full yield stress of the pole.

The handling and storing of materials, during and after fabrication, shall be done in such a manner that the metal or galvanized finish is not damaged. Material that is damaged may be rejected. Material shall be stored off the ground and properly drained. Loose members and fasteners shall be stored in boxes, crates, kegs or barrels.

Support structures shall be free from sharp edges and irregularities, and any misfits or structural deficiencies. All members must fit together well and make for an easy and quick erection. All components shall be protected from damage during fabrication, handling and transportation to the site. Unless approved by the Engineer, none of the components shall be delivered to the site until such time as the entire structure (less sign faces) can be erected.

(c) Overhead Roadway Sign Structures.

Material for overhead roadway steel sign structures shall be structural carbon steel or structural low alloy steel meeting the requirements of the AASHTO *Specifications for Highway Bridges*, latest edition. Steel pipe shall be in accordance with ASTM A 53, Grade B, Schedule 40 or stronger. Nuts, bolts, and washers used in structural joints shall be in accordance with ASTM A 325 and shall be installed in accordance with Item 508.03(d)6. Nuts and bolts used in non-structural joints shall be in accordance with ASTM A 307. Washers used in non-structural joints shall comply with the requirements of ASTM F 844.

All components of the structure assembly shall be galvanized with zinc after fabrication in accordance with AASHTO M 111 and ASTM B695 Class 50, for fasteners. Hollow sections shall be galvanized on both exterior and interior surfaces. Closed hollow sections shall have appropriate sized galvanizing vent holes at each end of a member. Damage to galvanization or any bare areas developed before or during erection shall be painted with two coats of approved galvanizing coating in accordance with Article 855.15.

A uniform camber, in accordance with Section 9 of the AASHTO Sign Specification, shall be provided for all horizontal members of the sign structure. The minimum camber shall be equal to the dead load deflection + L/1000 (L in inches {millimeters}). The maximum permissible camber shall be L/240 (L in inches{millimeters}).

1. Facilities for Inspection.

The Contractor/Fabricator shall provide ALDOT with adequate, suitable office facilities and equipment when required for the inspection of materials and workmanship in the fabrication plant. This office shall be conveniently located near the fabrication plant or work site, shall be private and not shared with any other agency and shall be equipped so that it may be locked. It shall be climate controlled, water tight and include necessary office furnishings such as desk/table, chairs and file cabinet. (Telephone is optional).

2. Quality Control and Non-Destructive Testing.

A current written copy of the fabricator's quality control manual, along with a listing of qualifications of personnel qualified to perform inspections and/or non-destructive testing shall be submitted prior to any fabrication work. All nondestructive testing personnel shall meet the requirements set forth in ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2011). Additionally, current copies of ASNT NDT Level III eye examinations are required.

No materials or members will be accepted by the Bridge Engineer's representative, or partial payments made, until the Department's BBF-1 form, the supporting mill test reports and galvanization certificates for the materials have been furnished and approved by the Department. This information shall be submitted for approval. The BBF-1 form shall be signed by a company official and notarized.

The contractor shall furnish certified copies of mill test reports covering steel materials. These reports shall include chemical determinations and physical characteristics.

The fabrication shop shall have and maintain a master tape, calibrated by the National Institute of Science and Technology. All tapes shall be calibrated with the master tape before being used on the project. Any master tape found damaged or with a certification over two years old shall be replaced or recalibrated.

A Certified Welding Inspector (CWI) shall be present on all shifts where welding is ongoing.

3. Handling, Transportation and Storage of Materials

The handling and storing of materials, during and after fabrication, shall be done in such a manner that the metal or galvanized finish is not damaged. Damaged material may be a cause for rejection. Material shall be stored off the ground and properly drained. Loose members and fasteners shall be stored in boxes, crates, kegs or barrels and kept dry.

4. Workmanship, Finish and Detailing.

All work shall be performed in a neat workmanlike manner.

A buffer and/or shield shall be utilized during fitting operations to protect base metals from damage caused by fitting tools or devices. Any damage incurred may be cause for rejection of the material.

Heat straightening or hot bending is allowable provided the metal is not heated above 1100 °F {590 °C}. The maximum heat applied shall be controlled by the use of heat crayons or other approved means. After straightening or bending, the metal shall not be artificially cooled until the temperature of the metal reaches 600 °F {315 °C} or less. Water or spray misting shall not be used as

a means of artificial cooling. Heat cambering will only be permitted when making minor adjustments to the actual camber in a member.

Steel may be thermal cut, provided a smooth surface is secured by the use of a mechanical guide. Thermal cutting by hand shall be done only when approved. The surface shall be smoothed by planing, chipping or grinding. Other methods of cutting steel may be considered for use.

Sheared edges of plates more than 5/8 inch {16 mm} in thickness shall be planed to a depth of 1/4 inch {6 mm}. Plates 5/8 inch {16 mm} in thickness, or less, shall be ground to remove sharp corners and edges.

Vent holes, if required, shall be cylindrical, without ragged or torn edges or corners. If vent holes are installed with a thermal cutting process, they shall be reamed.

5. Accuracy of Reamed or Drilled Holes.

Reamed or drilled holes shall be cylindrical and perpendicular to the member.

Holes may be punched with a full-size die provided the thickness of the material is not greater than the nominal diameter of the fasteners being used nor greater than 3/4 inch {20 mm} for carbon steel, 5/8 inch {16 mm} for high strength steel, nor 1/2 inch {12 mm} for quenched and tempered alloy steel. Holes shall be clean cut and free of torn or ragged edges. Plug welding of any holes that are too large or slightly off location is prohibited. Completed holes shall be 1/16 inch {1.6 mm} larger than the nominal diameter of the fastener being used.

All holes may be oversized or slotted by 1/32 inch {0.8 mm}, maximum. In any connection, no more than ten percent of all holes may be oversized or slotted 1/16 inch {1.6 mm}.

Edge distances of fasteners shall be as shown below.

The minimum distance from the center of any fastener to a sheared or flame cut edge shall be: 1" Fastener: 1-3/4" {45 mm}; 7/8" Fastener: 1-1/2" {38 mm}; 3/4" Fastener: 1-1/4" {32 mm}; 5/8" Fastener: 1-1/8" {29 mm}.

The minimum distance from the center of any fastener to a rolled or planed edge, except in flanges of beams and channels, shall be: 1" Fastener: 1-1/2" {38 mm}; 7/8" Fastener: 1-1/4" {32 mm}; 3/4" Fastener: 1-1/8" {29 mm}; 5/8" Fastener: 1" {25 mm}.

In the flanges of beams and channels the minimum distance from the center of the fastener to a edge shall be: 1" Fastener: 1-1/4" {32 mm}; 7/8" Fastener: 1-1/8" {29 mm}; 3/4" Fastener: 1" {25 mm}; 5/8" Fastener: 7/8" {22 mm}.

The distance between the edges of adjacent holes that are enlarged or slotted shall not be less than three times the diameter of the fastener minus the nominal diameter of the hole. The edge distance shall not be less than that given for Minimum Edge Distance minus one half the nominal diameter of the hole.

6. Welding.

a. All welding shall be inspected for defects in accordance with the requirements stated herein. Any worker, welder or weld inspector who, in the opinion of the Engineer, produces inferior work, may, under the provision of Article 108.06, be disqualified from performing ALDOT work.

b. All shop welding shall be performed under cover of a permanent structure and/or building capable of protecting the material and welding operation from inclement weather.

c. Intersecting welds, unless shown on the plans or approved shop drawings, are prohibited.

d. Tack welds, not incorporated in the final weld, shall not be used. Cracked tack welds shall be removed and the area of base material examined by MT or PT.

e. Complete penetration, circumferential welded splices, in any component of an upright member is prohibited within overhead sign structures.

f. Undercut is limited to 1/32" {0.8 mm} on secondary members and to 0.01" {0.25 mm} on main members.

g. Excessive arc strikes and/or gouges will be assessed by the ALDOT representative to determine if repairs are required or if the material should be rejected.

h. Carbon arc or thermal cut boundaries and back gouged surfaces for groove welds shall be ground to a smooth, bright surface, before welding.

i. Drying and storage ovens shall be electric and of sufficient size to accommodate a one day supply of electrodes. Drying ovens shall be equipped with a recording thermometer. Storage ovens shall have a visible thermometer.

j. Each welding machine shall have its approved welding procedure posted in a conspicuous area on or near the machine

k. The Contractor shall furnish a written welding procedure specification (WPS) for each process and joint to be used in shop welding. The WPS number shall appear in the tail of the weld symbol on the shop drawings.

l. All shop welds shall be temporarily marked in such a manner that allows identification of the welder.

m. A complete list of qualified welders and copies of the qualification records shall be provided by the fabricator. Welders that do not have satisfactory pre-qualification, may be required to qualify in the presence of an ALDOT representative or a third party Certified Welding Inspector (C.W.I.).

(d) Steel Poles for Traffic Signal, Luminaire and Traffic Surveillance Support Structures.

The shafts shall be fabricated from basic oxygen or open hearth sheet steel, of a single ply, and having only one longitudinal seam weld. Circumferential welded splices may be used, provided none of the spliced pieces, except for the top piece, are less than ten feet in length. All circumferential welds shall be ground flush with the material surfaces. In lieu of circumferential welds, a two piece section, slip joint shaft pole (for poles without horizontal welds) will be permitted when the plans or approved shop drawings require poles longer than the manufactured length capability.

Steel poles shall be anchored with a one piece cast steel anchor base or a welded steel plate anchor base that is of sufficient strength to develop the yield strength of the pole. When the anchor base is attached to the shaft it shall develop the full strength of the shaft section to resist bending action. The base shall be provided with four slotted holes for attachment to the foundation with four anchor bolts. The complete pole assembly shall be hot-dipped galvanized after fabrication in accordance with AASHTO M 111. Each assembly must be completely coated in a single dip. All miscellaneous hardware shall be galvanized per AASHTO M 232. Mill certifications shall be supplied.

891.03 Glass Fiber Reinforced Polymers (GFRP).

GFRP poles shall be heavy duty class, conforming to the American National Standard for Roadway Lighting-Fiber-Reinforced Plastic (FRP) Lighting Pole (ANSI C136.20 - latest edition). GRFP poles shall be manufactured by using a thermosetting polyester resin containing a minimum of 65% fiberglass by weight. The resin shall be ultraviolet resistant and pigmented the same color as the final coating to be applied. The resin shall not contain clay fillers. The pole color shall be uniform throughout the entire wall thickness of the pole. The finish of the pole shall be smooth. A 1-1/2 mil dry film thickness of weather resistant polyurethane shall be coated to the surface of the pole for additional ultra-violet protection.

Direct burial poles shall have a 4 inch by 6 inch {102 mm by 153 mm} hand hole with a non-aluminum cover provided at 18 inches {458 mm} above the ground line. The conductor entrance shall be two each 2 inch by 6 inch {51 mm by 51 mm} entrance holes located 2 feet {610 mm} below the ground line and one hundred and eighty degrees apart.

The poles shall be delivered pre-drilled to accommodate luminaires and lowering devices. Pole top tenons shall be permanently bonded to the shaft and shall be aluminum or hot dipped galvanized steel.

891.04 Aluminum.

Aluminum material shall meet the requirements of the AASHTO Sign Specifications, Section 5.

Welding shall be in accordance with the provisions of Section 5 of the AASHTO Sign Specifications.

The shaft of aluminum poles shall be one piece seamless round tapered tube full length heat-treated after welding on the base flange to produce the T6 temper. The base shall be one-piece cast aluminum. All nuts, bolts and washers used shall be stainless steel Grade 18-8 or stronger, and shall meet the requirements of ASTM F 593. Each pole will have an internal grounding lug. A pole vibration damper shall be provided.

The contractor shall furnish copies of certified mill test reports attesting to the fact that the aluminum material submitted for approval meets the contract requirements. These reports shall include chemical determinations and physical characteristics.

891.05 Prestressed Concrete Poles.

Concrete, reinforcing steel and prestressing steel for prestressed concrete poles shall meet the requirements given in Section 513. The concrete shall have a minimum 28 day compressive strength of 5000 psi {35 MPa} or as shown on the plans.

The prestressed concrete pole manufacturing plant shall follow the applicable requirements in ALDOT–367, Section 2, except that plant certification by the Precast/Prestressed Concrete Institute Plant Certification Program will not be required.

Within 30 days after the award of the contract, the Contractor shall notify the Materials and Tests Engineer in writing of the name and address of the fabricator of the poles.

Fabrication will not be allowed to begin until two weeks after the Materials and Tests Engineer has all of the approved details and submittals that are required for a representative of the Department to adequately inspect the fabrication of the poles. The Contractor shall arrange for a representative of the Department to conduct an inspection of the plant facilities and review the plant's Quality Control/Quality Assurance manual during this two week time period.

891.06 Breakaway Supports.

A Federal Highway Administration approved breakaway support shall be installed on each luminaire assembly when indicated on the plans. The pole shall meet the 1985 AASHTO breakaway requirements and FHWA certification of testing must be submitted. The Contractor shall assure the compatibility of the pole base, breakaway support and foundation.

Transformer bases shall be used only as a replacement of a like item on an existing installation unless specifically shown otherwise on the plans.

891.07 Mast Arms.

Mast arms shall be fabricated from steel tubes (except for aluminum poles, which shall have aluminum mast arms) to the lengths specified on the plans and approved shop drawings. Mast arm shafts shall be of one continuous piece without intermediate splices or couplings, provided with rain-tight connections to the shaft of the pole and designed to rotate three hundred and sixty degrees in the horizontal plane.

A two piece section, slip joint shaft mast arm will be permitted when plans or proposal require mast arms longer than the manufacturer's length capability.

All hardware, except split pole clamps, shall be stainless steel or anodized aluminum. The end of the arm shall be furnished with the type of fitting required by the plans.

All connecting joints for attachments for mast arms, shaft extensions and luminaire arms shall be of the design indicated by plan details or approved by the Engineer and shall develop full strength of the joint.

891.08 Anchor Bolt Assemblies.

Anchor bolt assemblies (anchor bolts, nuts, and washers) shall be in accordance with AASHTO M 314, Grade 36 or Grade 55, except maximum tensile strength on all grades is waived, and capable of transferring the load safely from the structure base plate to the foundation. The exposed end of the anchor bolts shall be threaded (rolled or cut type) and provided with appropriate nuts, including lock nuts and flat washers. The anchor bolts, nuts, and washers shall be hot-dipped galvanized in accordance with AASHTO M 232, however, galvanization of the bolt below 6 inches {152 mm} from the top of the embedment line will not be required. The nuts shall be lubricated with a lubricant containing a visible dye so that a visual check can be made for proper lubrication prior to installation. Special care shall be taken when storing galvanized bolts with a water soluble lubricant.

Anchor bolts for overhead roadway sign structures and high mast lighting assembly poles only, shall meet the requirements provided in AASHTO T 244 for Charpy V-Notch testing. Notch toughness tests on specimens shall be performed in accordance with Test Frequency P (Piece Testing) of AASHTO T 243 with a minimum average value of 15 ft-lb. at 40 °F {20 J at 4.4 °C} and the notch shall be oriented perpendicular to the longitudinal axes of the anchor bolt. In order to meet the Charpy V-Notch impact requirements, the steel may require heat treatment. The Charpy V-Notch testing equipment shall be calibrated once each year using a National Institute of Standards and Technology check sample. Certification of the annual calibration shall be available to the Department when requested.

891.09 Pedestals.

If specified by the plans, pedestals shall be furnished for steel and aluminum poles according to the overall length (including cap and base) shown on the plans. Pedestal shafts shall be a one piece, continuous taper or parallel wall, circular shaft. Steel shafts shall be of not less than 1/8 inch {3 mm} wall thickness and of a size at the top designed to fit a standard 4 inch {102 mm} slip-fitter attachment. Steel shafts shall have a polished or galvanized finish, which shall be protected during storage and shipment by a suitable protective covering. The covering shall remain on the shaft until installation begins. A one piece base shall be provided which, when attached to the shaft, will develop the full strength of the shaft to resist bending action. The base shall be provided with four slotted holes for attachment to the base of the foundation. The anchor bolts shall be recessed and ornamental covers provided. A handhole with cover, approximately 4 inches by 6 inches {102 mm by 153 mm} in dimension,

shall be provided in the base of the pedestal shaft. A cap for any exposed open end of a pedestal shaft shall be provided. The cap shall be of cast aluminum and of the nipple or tenon mounting type.

SECTION 893
INTELLIGENT TRANSPORTATION SYSTEMS MATERIALS

893.01 General.

The following are the requirements for Intelligent Transportation Systems (ITS). These requirements may be supplemented or amended by the requirements given elsewhere in the proposal, on the Plans, and on the details in the Special and Standard Highway Drawings.

Requirements as specified within these Specifications shall comply with the latest applicable editions of the National Electrical Code (NEC) (a.k.a. NFPA 70), the American Society of Testing and Materials (ASTM), the American National Standards Institute (ANSI), National Electrical Manufacturers Association (NEMA), National Fire Protection Association (NFPA), National Electrical Safety Code (NESC) (a.k.a. ANSI/IEEE C2), the Underwriter's Laboratory Incorporated (UL), International Organization for Standardization (ISO), Telecommunications Industry Association (TIA), the International Telecommunications Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), Electronic Industries Alliance (EIA), the National Transportation Communications for ITS Protocol (NTCIP), and the applicable standards, specifications, and regulations of ALDOT. In case of conflict with cited Standard Publications and the Specifications, the requirements of the Specifications shall govern.

(a) Compatibility.

All ITS devices and equipment shall be fully compatible and integrated with the current version of: "*ALDOT's Intelligent Transportation Systems software applications*" (also known as ALDOT's Advanced Transportation Management System or "*ALGo ATMS*"); ALDOT's ITS communications network; and, ALDOT's communication network management system. All items that are required to complete the installation and ensure a fully functional and operational system shall be supplied by the Contractor. Items required but not listed shall be at no direct pay. All components supplied by the Contractor are the responsibility of the Contractor.

893.02 Fiber Optic Cable.

(a) General.

1. Manufacturer Standards and Requirements.
   Each fiber optic cable shall meet all the following criteria:
   a. Manufacturer shall be Certified in accordance with International Organization for Standardization ISO 9001.
   b. Each cable shall meet the requirements of ANSI/Insulated Cable Engineers Association (ANSI/ICEA S-87-640) "Standard for Optical Fiber Outside Plant Communications Cable" (a.k.a. TIA-472D000) and United States Department of Agriculture (USDA) Rural Utilities Service (RUS) 7 Code of Federal Regulations (CFR) 1755.900.
   c. Fiber optic cable shall be factory tested and documented to pass and/or adhere to, and in accordance with, the following tests:

Telcordia GR-20	"*Generic Requirements for Optical Fiber and Optical Fiber Cable*"
ASTM-D1248, Type II, Class C, Category 4, Grade 4	"*Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable*"
ASTM-D1603	"*Standard Test Method for Carbon Black in Olefin Plastics*"
ASTM-D3895	"*Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry*"

ASTM-D4565	"*Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable*".

d. Fiber optic cable shall also be factory tested and documented to pass and/or adhere to, and in accordance with the most current ANSI/TIA/EIA-455 *"General Requirements for Standard Test Procedure for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components"*. The Fiber Optic Test Procedures (FOTPs) addenda, as they are applicable to the required fiber optic cable, are as follows:

ANSI/TIA/EIA-455-3	"*FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fiber Units, Optical Fiber, and Other Passive Fiber Components*"
ANSI/TIA/EIA-455-25	"*FOTP-25 Impact Testing of Optical Fiber Cables*"
ANSI/TIA/EIA-455-28	"*FOTP-28 Measuring Dynamic Strength and Fatigue Parameters of Optical Fibers by Tension*"
ANSI/TIA/EIA-455-31	"*FOTP-31 Proof Testing Optical Fibers by Tension*"
ANSI/TIA/EIA-455-33	"*FOTP-33 Optical Fiber Cable Tensile Loading and Bending Test*"
ANSI/TIA/EIA-455-37	"*FOTP-37 Low or High Temperature Bend Test for Fiber Optic Cable*"
ANSI/TIA/EIA-455-41	"*FOTP-41 Compression Loading Resistance of Optical Fiber Cables*"
ANSI/TIA/EIA-455-62	"*FOTP-62 Optical Fibres - Part 1-47: Measurement Methods and Test Procedures - Macrobending Loss*"
ANSI/TIA/EIA-455-78	"*FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation*"
ANSI/TIA/EIA-455-80	"*FOTP-80 Optical Fibres - Part 1-44: Measurement Methods and Test Procedures - Cut-Off Wavelength*"
ANSI/TIA/EIA-455-81	"*FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable*"
ANSI/TIA/EIA-455-82	"*FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable*"
ANSI/TIA/EIA-455-104	"*FOTP-104 Fiber Optic Cable Cyclic Flexing Test*"
ANSI/TIA/EIA-455-113	"*FOTP-113 Polarization-Mode Dispersion Measurement for Single-Mode Optical Fibers by the Fixed Analyzer Method*"
ANSI/TIA/EIA-455-175	"*FOTP-175 Optical Fibres - Part 1-42: Measurement Methods and Test Procedures - Chromatic Dispersion*"
ANSI/TIA/EIA-455-176	"*FOTP-176 Optical Fibres - Part 1-20: Measurement Methods and Test Procedures - Fibre Geometry*"
ANSI/TIA/EIA-455-181	"*FOTP-181 Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components*"
ANSI/TIA/EIA-455-191	"*FOTP-191 Optical Fibres - Part 1-45: Measurement Methods and Test Procedures - Mode Field Diameter*"

These industry standards listed above shall be of the most current active version. If a standard is withdrawn by the authorizing organization, then the superseding standard(s) shall apply.

All fiber optic cable supplied and utilized on this project shall be from a single (one) United States (U.S.) resident manufacturer who can demonstrate that said manufacturer is regularly, and for a minimum of five (5) previous years (continuous), engaged in the production of each, every and all specified fiber optic cable(s) herein and shall warrant that said cable(s) shall be produced utilizing the manufacturing processes for said cable(s) noted within this Specification.

All fiber optic cable(s) supplied and utilized shall be manufactured from U.S. made components only, with the exception of aramid yarn. The Contractor shall notify the Engineer of the use of foreign aramid yarns at submittal.

In the event that U.S. resident manufactured fiber optic cable is readily unavailable due to excessive lead time, as specified by the Construction Engineer, for production, the Contractor may submit, with or prior to the material submittals, a Non-U.S. based cable manufacturer cable meeting requirements to the Engineer for consideration of acceptance. The Contractor shall submit to the Engineer letters from U.S. based manufacturers documenting the excessive lead time.

2. Fiber Optic Characteristics.

Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements as specified within the Specifications.

The coating shall be dual layered, ultraviolet (UV) cured acrylate. The coating shall be mechanically or chemically strippable without damaging the fiber.

The required optical fiber grade shall reflect the maximum individual fiber attenuation, to guarantee the required performance of every fiber in the cable.

Only single-mode all-dielectric fiber optic cables shall be used unless otherwise specified on the Plans.

Optical fiber shall also meet the following criteria:

PARAMETERS	SINGLE-MODE VALUES
Standards	International Telecommunication Union (ITU)-T G.652.D International Electrotechnical Commission (IEC) 60793-2-50 Type B.1.3 Dispersion unshifted single-mode TIA 492-CAAB
Type	Step Index
Core Diameter	8.3 µm (Nominal)
Proof Tensile Test	100 kpsi {0.69 GN/m² or 0.69 GPa}
Operating Temperature Range	-40°F to 158°F {-40°C to 70°C}
OPTICAL SPECIFICATIONS	
Attenuation (Maximum): @ 1310 nm-1625 nm (SM) @ 1550 nm (SM)	 ≤ 0.4 dB/km ≤ 0.3 dB/km
Cut-Off Wavelength (λ_{cc})	$\lambda_{cc} \leq 1260$ nm
Mode Field Diameter (MFD): Nominal range @ 1310 nm	 (8.6 µm – 9.5 µm) ± 0.6 µm
Dispersion (Maximum): @ 1285 nm – 1330 nm @ 1550 nm	 ≤ 3.3 ps/(nm•km) ≤ 18 ps/(nm•km)
Chromatic Dispersion, Zero Dispersion (λ_o)	1300 nm ≤ λ_o ≤ 1324 nm
Wavelength Zero Dispersion Slope (S_o)	$S_o \leq 0.092$ ps/(nm²•km)
GLASS GEOMETRY	
Cladding Diameter	125.0 µm ± 1.0 µm
Core to Cladding Offset	≤ 0.8 µm
Cladding Non-Circularity	≤ 1.0%
COATING GEOMETRY	
Coating Diameter (OSP)	250 µm ± 15 µm

3. Cable Markings.

Cable markings shall be indent printing with white characters on the outer jacket. The characters shall be approximately 3 mm in height and spaced to produce good legibility. The cable

shall be sequentially marked at 3 feet {0.91 m} intervals maximum. The length marks will not run through zero on any length of cable. The length markings are to be in feet. The maximum variance between the actual cable length and marked cable length is ± 1%.

Each length of cable shall be marked with the following legend:

"(Mfg. name) OPTICAL CABLE (Cable Description) (Mfg. month and year) (telecommunications headset symbol) ALDOT XXXF"

where "XXX" denotes the number of fibers within the cable.

Note: Special marking of "ALDOT XXXF" is not required if the individual reel cable length is less than 6,300 feet {1,920 meters}.

No re-marking of cables is allowed without prior approval by the Engineer.

4. Color Coding.

Buffer tubes and individual optical fibers within those buffer tubes shall adhere to ANSI/TIA/EIA-598-C "*Optical Fiber Cable Color Coding*" as follows:

1 = Blue (BL)	2 = Orange (OR)	3 = Green (GR)	4 = Brown (BR)	5 = Slate (SL)	6 = White (WH)
7 = Red (RD)	8 = Black (BK)	9 = Yellow (YL)	10 = Violet (VI)	11 = Rose (RS)	12 = Aqua (AQ)

where legend for above is: "fiber/tube number = color code (abbreviation)".

For cables containing more than 12 buffer tubes, use the color code shown above for tubes 1 through 12, and use stripes or tracers in conjunction with the standard color code for tubes 13 through 24.

The colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel-filling/water blocking material. Ensure colors do not cause fibers to stick together.

5. Outside Plant (OSP) Manufacturing.

All optical fiber cables shall be outside plant cable and loose tube. Fiber cable shall contain the fiber count as shown on the Plans with 6 or 12 fibers per buffer tube as allowed for cable type (trunk, drop, etc.).

A layer of aramid yarns, along with at least one ripcord, shall be applied over the buffer tube bundle, producing the cable core.

The cable core interstices and buffer tubes interstices shall be protected from water intrusion by water blocking material. Water blocking material shall be gel or dry; and, be designed to prevent the ingress of water. Water blocking material shall be non-hygroscopic, non-nutritive to fungus, electrically non-conductive, and homogeneous. Water blocking material shall also be free from dirt and foreign matter and readily removable with conventional non-toxic solvents.

Cable jacket shall be a circular extrusion medium density polyethylene (MDPE) of 1.3 mm minimum thickness with no bubbles or blisters and shall be suited for conduit, duct, direct burial and aerial lashing. Jacketing material shall be directly applied over the central tensile strength members and water blocking material.

The buffer tubes shall have a 2.5 mm outer diameter. Each tube shall have water blocking material as specified above. Buffer tubes shall be wrapped around the central strength member in reverse oscillation manner (a.k.a. S-Z spanning) so that the cable may be broken into and fibers selectively broken out without having to cut the entire cable.

6. Quality Assurance and Packing.

The cable shall be packaged wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be as to prevent damage to the cable during shipping and handling.

When the cable length creates a reel weight exceeding 800 lbs. {362.87 kg}, the manufacturer shall be required to supply the cable on a large wooden reel and the reel shall be lagged with wooden staves. The cable shall be covered with a thermal wrap. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project a minimum of 10 feet {3.0 m} into a slot in the side of the reel or into housing on the inner slot of the drum, in such a manner to make it available for testing. An arbor hole of 1.5 inch {3.8 cm} minimum is required.

Test tails shall be at least 6.5 feet {2.0 m} and accessible from the outside of the reel. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation.

End seals shall be applied to each end of the cable to prevent moisture from entering the cable. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.

Each reel shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

Documentation shall accompany each reel. The documentation shall indicate the attenuation of each cable fiber in dB/km. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode.

Each reel shall have stenciled on the reel or a weatherproof reel tag firmly attached identifying (at a minimum) the following:

- Name of Cable Manufacturer and Address
- Type Fiber Optic Cable
- Number of Fibers
- Length of Cable (ft/m)
- Reel Number
- Direction of Rotation
- "DO NOT LAY REEL ON SIDE"

A cable reel data sheet (a.k.a. manufacturer's certified test report) shall accompany each cable reel. The following information (at a minimum) shall be included:

- Name of Cable Manufacturer and Address
- Cable Number
- Reel Number
- Year of Manufacture
- Factory Order Number
- Customer Purchase Order Number
- Type Fiber Optic Cable
- Number of Fibers
- Measured Attenuation of Each Fiber (for lengths > 1000 m)
- Ordered Length (ft/m)
- Actual Shipped Length (ft/m)

This cable reel tag and data sheet are to be delivered to the Engineer as defined in the Construction Section of this Specification.

(b) Trunk Cable.

All optical fiber trunk cables shall be outdoor rated cable (non-plenum) and loose tube. Trunk cable shall contain the fiber count with 12 fibers per buffer tube as shown on the Plans.

Trunk fiber cable shall have a maximum pulling tension rating of 600 lbf {2700 N} or as recommended by the manufacturer. Trunk cable must be able to withstand a minimum bending radius of 10 times the cable diameter under no load and 20 times the cable diameter under load without affecting the performance characteristics of the cable. Maximum pulling tension shall be 600 lbf {2700 N} during installation (short-term) and 180 lbf {810 N} long-term installed or as recommended by manufacturer.

(c) Drop Cable.

All optical fiber drop cables shall be outdoor rated cable (non-plenum) and loose tube. Fiber drop cable shall contain the fiber count of 6 or 12 fibers per buffer tube as shown on the Plans.

In addition to the GENERAL requirements previously listed, each drop cable shall also meet the requirements of ANSI/ICEA S-110-717, "*Standard for Optical Fiber Drop Cable*" (a.k.a. ANSI/TIA-472F000).

Drop cable shall be sheathed with flame retardant polyvinyl chloride (PVC) and shall be an all-dielectric manufacturing. The nominal jacket thickness shall be 1.4 mm and shall be applied directly over the tensile strength member(s). The PVC jacket shall contain carbon black to provide ultra-violet (UV) protection and shall not promote the growth of fungus. The cable shall meet the requirements of the NEC Section 770 for Non-Plenum Applications – Applicable Flame Tests: ANSI/UL 1666 and shall be rated OFNR (optical fiber nonconductive riser).

Drop cable with 12 fibers or less shall be a single buffer tube with a maximum pulling tension rating of 300 lbf {1350 N} during installation (short-term) and 90 lbf {400 N} long-term installed or as recommended by manufacturer. Drop cable with more than 12 fibers shall have multiple buffer tubes of 12 with a maximum pulling tension of 600 lbf {2700 N} during installation (short-term) and 180 lbf {810 N} long-term installed. The buffer tubes shall have a 2.5 mm outer diameter. Each tube shall be dry with either water blocking yarn, powder, or liner. Buffer tubes shall be wrapped around the central strength member in a reverse oscillation manner (a.k.a. S-Z spanning) so that the cable may be broken into and fibers selectively broken out without having to cut the entire cable.

(d) Armored Cable.

All optical fiber armored cables shall be outdoor rated cable (non-plenum) and loose tube. Armored cable shall contain the fiber count with 12 fibers per buffer tube as shown on the Plans. Armored cable shall also contain a corrugated steel tape armor located between two MDPE jackets (i.e., double-jacketed).

Armored fiber cable shall have a maximum pulling tension rating of 600 lbf {2700 N} or as recommended by manufacturer. Armored cable must be able to withstand a minimum bending radius of 10 times the cable diameter under no load and 20 times cable diameter under load without affecting the performance characteristics of the cable. Maximum pulling tension shall be 600 lbf {2700 N} during installation (short-term) and 180 lbf {810 N} long-term installed or as recommended by manufacturer.

Armored fiber optic cable with messenger wire manufactured within the cable shall NOT be allowed for aerial cable. Similarly, no metallic central strength member serving as a messenger wire shall be allowed for aerial cable. Aerial fiber optic cable may be armored or not armored.

(e) Aerial Slack Bracket.

Aerial Slack Bracket (a.k.a. snowshoes) shall be used for the management of aerial fiber optic cable slack storage loops (a.k.a. maintenance coils). The aerial slack bracket shall protect the minimum bending radius of the fiber optic cable.

The aerial slack bracket shall be nonconductive, polymer based, ultra-violet (UV) treated plastic, rated twenty-years in the outdoor environment. Stainless steel hardware shall be used for attaching this aerial slack bracket to the messenger wire. Predrilled holes shall be included along the bracket for securing the fiber optic cable to the bracket.

(f) Fiber Optic Tag.

1. General.

All fiber optic cabling shall be labeled with a unique identification in a permanent and consistent manner that is approved by the Engineer prior to installing fiber cable. The Engineer shall provide the Contractor with the identifications to be used.

All fiber cable tags shall be of a material designed for long term permanent labeling of fiber optic cables and shall be marked with permanent ink on non-metal types or embossed lettering on metal tags. Metal tags shall be manufactured of stainless steel. Non-metallic tags shall be nonconductive, polymer based, ultra-violet (UV) resistant, rated twenty-years in the outdoor environment, and durable to extreme weather conditions. Cable tag and label materials shall be approved by the Engineer.

2. Aerial Fiber Cable Labeling.

Aerial fiber optic cable tag shall be nonconductive, polymer based, ultra-violet (UV) resistant, rated twenty-years in the outdoor environment, and durable to extreme weather conditions.

Aerially-mounted fiber optic cable shall be marked with a yellow retroreflective tag with black print containing the graphic system as shown on the Plans. The tags shall make the cable identifiable as ALDOT fiber when viewed from ground level. The black on yellow graphic system shall not fade, peel or chip.

See corresponding Construction Section for fiber optic cable label "*proof check*" sample and approval requirements.

893.03 Fiber Distribution Units (FDU), Connectors, and Fan-Out Kit.

(a) General.

1. Distribution Hardware.

The following material specifications covers Fiber Distribution hardware requirements from the headend and hub, primary fiber distribution unit (PFDU) to secondary fiber distribution unit (SFDU)

which are utilized within the individual cabinets and communication closets within buildings or within hub buildings.

2. Fiber Optic Connectors.

Fiber Optic Connectors shall be Type **SC** for single-mode applications unless specified otherwise on the Plans or in these Specifications; and, shall meet the requirements of TIA/EIA-604, "*Fiber Optic Connector Intermateability Standards (FOCIS)*" along with the associated test document addendum FOCUS-3. Fiber optic connectors shall be Telcordia GR-326 certified and must meet applicable TIA/EIA-4750000, IEC 61754, and JIS C5973 standards.

Connector and adapter plug bodies for single-mode fiber optic cable shall be blue in accordance with color coding requirements of TIA/EIA-568-C.3 "*Optical Fiber Cabling Components Standard*".

Fiber optic connectors shall not exceed 0.50 dB insertion loss per connector pair across a single fiber regardless of whether field or factory, mechanical or heat cure epoxy terminated.

(b) Primary Fiber Distribution Unit (PFDU).

Primary Fiber Distribution Unit (PFDU) shall be utilized within the primary hub and headend facility that is in support of the hub distribution system and the primary network. This point in the system allows the distribution of signals directly to the network electronics via a jumper/patchcord cable management system.

1. The PFDU is characterized as modular, powder coated aluminum.
2. The termination method for PFDU shall be field termination of inbound fiber cable and patchcord method of connectivity to other outbound cables and network electronics. PFDU may also use pre-terminated factory connector build-outs (Pre-terminated Connector Assemblies) with adapter ports preinstalled as an alternative method.
3. The PFDU shall be mountable within a 19 inch {482.6 mm} EIA-310 rack or bay and have a typical dimension of approximately 8 inches {203.2 mm} high (i.e., 4-U), by 19 inches {482.6 mm} wide by 18 inches {457.2 mm} deep.
4. The PFDU hardware shall be easily adaptable for bay routing of patchcords and cable.
5. Each PFDU maximum connector capacity shall be 72 or 144 fibers, 12 adapter panels.
6. The maximum number of adapters per build-out shall be twelve.
7. PFDU may include factory connector build-outs with adapter ports preinstalled.
8. PFDU shall manage splice trays capable of handling the PFDU maximum capacity of fiber splices.
9. All PFDU hardware shall be lockable with an interior key lock.

(c) Secondary Fiber Distribution Unit (SFDU).

Secondary Fiber Distribution Unit (SFDU) shall be wall mounted or 1U as required by cabinet for device to be installed. Mounting shall use brackets and/or backer plates; no exterior wall penetrations shall be allowed. SFDU shall be small enough to fit in limited area or wall space.

1. SFDU is characterized as modular, powder coated aluminum.
2. SFDU may include pre-terminated factory connector build-outs (Pre-terminated Connector Assemblies) with adapter ports preinstalled.
3. SFDU shall be modular with separate splicing, connector, and jumper managements.
4. SFDU panels shall come in 12 or 24 fiber capacity, project specific.
5. SFDU shall manage splice trays capable of handling 24 fiber splices, minimum.
6. The maximum number of adapters per build-out shall be twelve.
7. The panel shall have some locking mechanism, either exterior (lock) or interior key.

(d) Fan-Out Kit.

Fan-Out Kits shall be used on all loose tube and central core fiber optic cable at each terminal end when cable end is to be terminated. The fan-out kit can be an individual buffer tube kit, a multiple buffer tube kit, or spider design kit. All fan-out kits shall have a minimum of 24 inch {61 cm} of tubing, measured from cable end to the back of the connector body, covering each fiber when installation is complete. Fan-out kits shall be rated for outdoor use within a temperature range of -40°F to 158°F {-40°C to 70°C}.

Only one type of fan-out kit may be used on any one project.

(e) Heat Cure Epoxy Connectors.

Heat Cure Epoxy Connectors shall be ceramic ferrule, nickel plated zinc connector body (composite connector body for corrosive atmospheres), 125µm diameter fiber, with the fiber permanently secured

within the ferrule with epoxy (heat epoxy cured or air dried) as specified by the connector and/or the epoxy manufacturer. The operating temperature shall be between -40°F to 167°F {-40°C to 75°C}.

(f) Mechanical Connectors.

Mechanical Connectors shall be high-precision ceramic ferrule connectors with guaranteed insertion loss 0.2 dB typical/0.5 dB maximum per connector pair for single-mode. Cleaver, mating tool and mechanical connector shall be of the same manufacturer and specified to be compatible. Mating tool to install the mechanical connector shall be handheld operated and provide immediate verification that proper mating of the mechanical connector was successful or unsuccessful. Cleaver shall include dual stage clamping which holds the fiber (1st stage) before cleaving (2nd stage). Cleaver shall use a diamond blade for high-precision. Mechanical connectors shall not require epoxy or post installation polishing.

(g) Pre-terminated Connector Assemblies.

Pre-terminated Connector Assemblies (i.e., Factory Connector Build-Outs, or pigtails) consist of fiber optic cables with factory-installed connectors on one end of the cable and an un-terminated optical fiber on the other. Pre-terminated Connector Assemblies shall meet the optical fiber and cable requirements within this Specification. The connectors on the factory connector build-out shall be heat cured epoxy connectors meeting specified requirements. Pre-terminated Connector Assemblies shall be installed with fusion splices; and, shall be equivalent in length of the fan-out field termination approach. Splices shall be housed in the appropriate fiber distribution equipment and installed using heat shrink protectors. Fusion splice shall meet specified requirements for maximum attenuation loss.

Pre-terminated Connector Assemblies' optical fiber shall match the mode field diameter (MFD) of the fiber optic cable to which it will be spliced. MFD must be matched to minimize dB losses between optical fibers.

(h) Patch Cable.

Fiber optic Patch Cable assembly (a.k.a. patchcords or jumpers) shall be all-dielectric, single-mode fiber design with the appropriate termination as required herein and as shown on the Plans. The fiber optic cable and optical fiber shall meet the General requirements of **Sub-Article 893.02(a)**. Patch cable shall be yellow in color (single-mode) and shall incorporate tight buffered fiber, aramid yarn strength member and an outer jacket. Fiber patch cables shall be pre-connectorized; and shall meet the connector requirements herein and as shown on the Plans.

All single-mode duplex patch cables, zip cord or round, shall have connector boots of two (2) colors: white or off-white for one leg of the duplex cord (non-printed zip leg) and blue for the opposite leg (printed zip leg) of the duplex cord in accordance with TIA/EIA-568.3-D "*Optical Fiber Cabling Components Standard*".

All connectors used shall have an operating temperature range of -40°F to 158°F {-40°C to 70°C}. Each connector is to have a minimum of a 1.0 inch {25 mm} strain relief boot and shall match the patch panel and/or fiber equipment being connected without adaptors.

Each assembly shall be fully tested per the Fiber Optic Association (FOA) Standard FOA-2 to verify that the patch cable does not exceed the acceptable loss of the connector and fiber cable. Each assembly shall be individually packaged within a plastic bag that shall have the submitted manufacturer's part number marked clearly on the outside of bag. Each patch cable shall be labeled as directed by the Engineer.

893.04 Network Devices.

(a) General.

The following Network Device material specifications covers equipment requirements for ethernet network elements (links, nodes, switches, etc.) which will provide the ITS communications network from the Regional/Area Traffic Management Center to the ITS field components and other stakeholders. These Network Devices will typically reside within the individual cabinets and communication closets within buildings or within hub buildings.

Network Devices and components shall be provided and installed at all locations as shown on the Plans. Furnished materials and equipment shall be new, free from defects, and manufactured using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance. Hardware and fittings shall be galvanized, stainless steel or other non-corrosive metal.

1. Managed Ethernet Switch (MES).

The Managed Ethernet Switch (MES) shall be equipped to operate at Fast Ethernet (10/100 Mbps) data rates for local devices and gigabit Ethernet rates for all uplink ports. MES shall be metal housing construction and have diagnostic light emitting diodes (LED), including link, TX, RX, and power LEDs. The Contractor shall provide items such as cables, connectors, software, modules, Small Form Pluggable (SFP) optics, etc. which are necessary for a complete and operational system. MES shall have an operating temperature range of -40˚F to 185˚F {-40˚C to 85˚C} and an operating ambient humidity of 5% - 95% (non-condensing), without fans. Materials furnished, assembled, fabricated, and/or installed under this item shall be compliant with the Institute of Electrical and Electronics Engineers (IEEE) 802.3 Ethernet standards, shall be manufactured to ISO 9001 Quality Assurance specifications, and shall be Engineer reviewed and accepted. MES shall comply with the EIA/TIA Ethernet data communication requirements using single-mode fiber optic transmission medium and Category 6 copper transmission medium. The MES shall have a minimum Mean Time Between Failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 *"Reliability Prediction Procedure for Electronic Equipment"* handbook/standard.

Equipment shall be new and corrosion resistant. Power supply shall accept 120 Vac and as defined within the specific MES Layer power requirements. MES shall have the following features:

DESCRIPTION	SPECIFICATION
Ethernet Connectivity	1000 Mbps
Ingress Protection	IP30
Switching Method	Store & Forward
Priority Queues	4
Simultaneous Virtual Local Area Networks (VLAN)	255
VLAN ID Range	1 - 4000
Internet Group Management Protocol (IGMP) multicast groups	250
Port Rate Limiting	128 kbps - 8 Mbps
No head of line blocking	Yes

MES shall comply with all applicable IEEE network standards for Ethernet communications, including but not limited to:

802.3-10 BaseT	802.1d - Spanning Tree Protocol
802.3u-100 BaseTX, 100 BaseFX	802.1p - Class of Service
802.3x-Flow Control	802.1Q - VLAN Tagging
802.3z-1000 BaseLX	802.1w - Rapid Spanning Tree Protocol
802.3ab-1000 BaseTX	802.1x - Port Based Network Access Control
802.3ad-Link Aggregation	802.1Q-2005 - Multiple Spanning Tree Protocol (MSTP)
802.1d-Media Access Control (MAC) Bridges	802.3ae-2002* – 10 Gigabit Ethernet (10GBase) *(* where indicated by network device Type)*

MES shall support Layer 2 management features and some higher-level multicast data transmission and routing features. These features shall include, but not be limited to:

Hyper Text Transfer Protocol Secure (HTTPS) graphical web-based, SSL (128-bit encryption)	Secure Shell (SSH)
Simple Network Management Protocol (SNMP) v1, v2c, v3 (56-bit encryption)	Role Based Access Control
SSH/Secure File Transfer Protocol (SFTP) (128-bit encryption)	Remote Monitoring (RMON)
Command Line Interface (CLI)	Remote Syslog
Rivest-Shamir-Adleman (RSA) Key Management (1024 bit key)	Rich set of diagnostics with logging and alarms
RADIUS client, Point to Point Protocol (PPP)	

All MES shall meet the following power and environmental requirements:

Fully integrated power supply internal to switch	UL 60950 safety approved with operating temperature tested at 185°F {85°C} for 16 hours
Universal high-voltage range: 88 - 830 Vdc or 85 - 264 Vac	Terminal blocks for reliable maintenance free connections

The ports for the MES shall meet or exceed the following specifications:

SFP Pluggable Optics	Long haul optics allow Gigabit distances up to 43.5 mi {70 km}
Two transmit and receive ports	Bi-directional single strand fiber support

All MES shall pass or exceed the following approvals:

Hazardous Locations: Class 1, Division 2	Emissions: Federal Communications Commission (FCC) Part 15 (Class A), EN55022 (CISPR22 Class A)
ISO: Designed and manufactured using an ISO 9001 certified quality program	Safety: cCSAus (Compliant with CSA C22.2 No. 60950, UL 60950, EN60950)
European Conformity (CE) Marking	Laser Eye Safety (US Food and Drug Administration (FDA)/Center for Disease and Radiological Health (CDRH)): Complies with 21 Code of Federal Regulation (CFR) Ch.1, Subchapter J, Part 1040

MES shall be in compliance with the following standards, to reduce potential interference with/by other devices when in close proximity:

IEC 61000-6-2 Industrial (Generic)	IEEE 1613 Electric Utility Substations
IEC 61800-3 Industrial (Variable Speed Drive Systems)	NEMA TS2 Traffic Control Equipment
IEC 61850-3 Electric Utility Substations	Failsafe Output Relay: for critical failure or error alarming

MES shall have the following features, to ensure only technicians authorized by ALDOT can operate the switch:

Multi-level user passwords	VLAN (802.1Q) to segregate and secure network traffic
SSH/SSL: 128 bits	RADIUS centralized password management
Enable/disable ports, MAC based port security	SNMP v3 authentication and 56-bit encryption
Port based network access control (802.1x)	(No Telnet or unsecure web-based access is to be allowed.)

MES shall have the following protocols:

Authentication	Dynamic Host Configuration Protocol (DHCP) Agent (Option 82 Capable)

2. Optical Ports.

Optical fiber (link) ports shall operate at 1310 or 1550 nanometers in single-mode. The optical ports are to be Type ST, SC, LC, or FC only, as shown on the Plans. Mechanical transfer registered jack (MTRJ) type connectors shall not be allowed. Each optical port shall support: paired fiber communications (i.e., one fiber will transmit (TX) data and one fiber will receive (RX) data); or, bi-directional TX and RX over one fiber. The optical ports shall have an optical power budget of at least 15 dB for 10K optics. MES shall have a minimum of two optical SFP transceiver ports.

3. Copper Ports.

Copper ports shall use 8P8C (a.k.a. type RJ45 "unkeyed") modular jacks and shall auto-negotiate speed (i.e., 10/100/1000 Base at a minimum) and duplex (i.e., full or half). These 10/100/1000 BaseTX ports shall meet the requirements detailed in this Section and shall be compliant with the IEEE 802.3 standard pin outs.

4. CAT Network Cable.

Category 5E unshielded twisted pair/shielded twisted pair network cables shall be compliant with the TIA/EIA-568-A standard. Category 6 or Category 6A unshielded twisted pair/shielded twisted pair network cables shall be compliant with the TIA/EIA-568-C.2 standard. When installed outdoors, the above category (CAT) cables shall be outdoor rated. Color(s) of CAT cable jackets shall be as approved by the ALDOT Region Transportation System Management and Operations (TSM&O) Engineer.

(b) Wired Network Devices.

1. Type A - Core Managed Ethernet Switch (CMES).

Core Managed Ethernet Switches (CMES) are typically installed in the Department Traffic Management Center (TMC), office buildings, or hub cabinets/buildings to support the wide area network (WAN). CMES shall be **Layer 3 (Core)**, with capabilities including but not limited to: architecture standardization, open connectivity (i.e., interoperability), bandwidth management, rate limiting, security filtering, and general integration management of an advanced Ethernet switching architecture. CMES shall have the following additional features:

DESCRIPTION	SPECIFICATION
Mounting	Rack or Panel mountable
Switching Latency	≤ 10.5 µs
Switching Bandwidth	≥ 88 Gbps
MAC addresses	≥ 98304
MAC address table size	≥ 64 kbytes
Frame buffer memory	≥ 2 Mbit
Network Management	NETCONF
Management Tools	Loopback diagnostic tests Raw and interpreted real timeline traces
Power Supply	Power supply shall be modular and hot swappable Fully integrated, dual-redundant power supplies
Ethernet Ports	Fiber Optical (SFP) Gigabit Ethernet Ports minimum: 2 each – 10GBase, 18 each – 1000 BaseTX Copper/RJ45 Fast Ethernet Ports (10/100/1000 BaseTX) minimum: 16 each
Optical SFP Transceivers	Provide SFP transceiver modules (Type LC) with quantity minimums as follows: a. ten (10) each that transmit at distances of 10 km, and b. ten (10) each that transmit at distances of 40 km
Serial Ports	Fully compliant EIA/TIA RS-485, RS-422, RS-232 serial ports Distributed Network Protocol (DNP) MODBUS Raw socket mode allows conversion of any serial protocol
Layer 3 Protocols	Multilink PPP RFC 1990 GOOSE messaging support IP Routing: OSPF, BGP, RIPv1, RIPv2, VRRP Traffic Control, Network Time Protocol (NTP) Server, Internet Protocol (IP) Multicast Routing PIM SM PPP RFC 1661, 1332, 1321, 1334, PAP, CHAP Frame Relay RFC 1490 or RFC 1294 WAN

2. Type B - Aggregation Managed Ethernet Switch (AMES).

Aggregation Managed Ethernet Switch (AMES) are typically installed in hub cabinets to support the communications WAN. AMES shall have **Layer 2 and/or Layer 3** capabilities (aggregate switch/router) as defined within this Specification. AMES shall also include but not be limited to: architecture standardization, open connectivity (i.e., interoperability), bandwidth management, rate limiting, security filtering, and general integration management of an advanced Ethernet switching architecture. AMES shall have the following additional features:

DESCRIPTION	SPECIFICATION
Mounting	Rack Mountable
Switching Latency	≤ 8 µs
Switching Bandwidth	≥ 10 Gbps
MAC address table size	≥ 64 kbytes
Frame buffer memory	≥ 1 Mbit
Network Management	NETCONF
Management Tools	Loopback diagnostic tests Raw and interpreted real timeline traces
Power Supply	Power supply shall be modular and hot swappable Fully integrated, dual-redundant (optional) power supplies
Ethernet Ports	Fiber Optical (SFP) Gigabit Ethernet Ports (1000 BaseX) minimum: 6 each Copper/RJ45 Fast Ethernet Ports (10/100/1000 BaseTX) minimum: 6 each
Optical SFP Transceivers	Provide SFP transceiver modules (Type LC) with quantity minimums as follows: a. six (6) each that transmit at distances of 10 km, and b. two (2) each that transmit at distances of 40 km
Serial Ports	Fully compliant EIA/TIA RS-485, RS-422, RS-232 serial ports DNP MODBUS Raw socket mode allows conversion of any serial protocol
Layer 3 Protocols	Multilink PPP RFC 1990 GOOSE messaging support IP Routing: OSPF, BGP, RIPv1, RIPv2, VRRP Traffic Control, NTP Server, IP Multicast Routing PIM SM PPP RFC 1661, 1332, 1321, 1334, PAP, CHAP Frame Relay RFC 1490 or RFC 1294 WAN
Frame Relay Support	ISO and ITU compliant, network certified ANSI T1.617 Annex D, Q.933 or Local Management Interface (LMI) Local Signaling
WAN Port Options	T1/E1 (channelized/unchannelized) E1 75 ohms (Ω) via BNC Cellular (HSPA/EVDO) DDS

3. Type C - Field Managed Ethernet Switch (FMES).

Field Managed Ethernet Switch (FMES) are typically installed in the ITS Cabinets to support the ITS field equipment (e.g. cameras, VDS, and DMS). FEMS shall be **Layer 2** capable. FMES shall have the following additional features:

DESCRIPTION	SPECIFICATION
Mounting	DIN Rail or Panel mountable
Switching Latency	≤ 8 µs
Switching Bandwidth	≥ 5.6 Gbps
MAC address table size	≥ 32 kbytes
Frame buffer memory	≥ 1 Mbit

Electromagnetic Interference (EMI) Immunity and Environmental Compliance	BS EN 50121-4 "*Railway Applications – Electromagnetic Compatibility – Part 4: Emission and Immunity of the Signaling and Telecommunications Apparatus*"
Management Tools	Telnet (not for remote control), Command Line Interface (CLI) management interfaces
Ethernet Ports	Fiber Optical (SFP) Gigabit Ethernet Ports (1000 BaseX) minimum: 2 each Copper/RJ45 Fast Ethernet Ports (10/100/1000 BaseTX) minimum: 8 each
Optical SFP Transceivers	Provide SFP transceiver modules (Type LC) with quantity minimums as follows: a. two (2) each that transmit data at distances of 10 km

(c) Wireless Network Devices.

1. Wireless Managed Ethernet Switch (WMES).

Wireless Managed Ethernet Switch is network switch that is to be installed in field level device cabinets to support the communications network at remote areas where physically hardwired communications infrastructure is not available. The WMES shall provide wireless 802.11b/g 2.4 GHz connectivity at transmission rates up to 54 Mbps from the remote ITS device installation location to the ITS network trunk interconnection point. WMES shall be **Layer 2** capable. WMES shall include the following additional features:

DESCRIPTION	SPECIFICATION
Mounting	DIN Rail or Panel mountable
Switching Latency	≤ 8 µs
Switching Bandwidth	≥ 1.8 Gbps
MAC address table size	≥ 16 kbytes
Frame buffer memory	≥ 1 Mbit
Electromagnetic Interference (EMI) Immunity and Environmental Compliance	BS EN 50121-4 "*Railway Applications – Electromagnetic Compatibility – Part 4: Emission and Immunity of the Signaling and Telecommunications Apparatus*"
Management Tools	Telnet (not for remote control), CLI management interfaces
Ethernet Ports	Copper/RJ45 Fast Ethernet Ports (10/100 BaseTX) minimum: 8 each

2. Licensed Wireless Network Device.

The Licensed Wireless Network Device and components shall be a microwave system utilizing a Federal Communications Commission (FCC) approved 6 to 40 GHz broadband communication package to be used for the backbone communications as shown on the Plans. The microwave shall be a split system consisting of an Indoor Unit (IDU) modem and an Outdoor Unit (ODU) radio that is mounted directly to the antenna. The IDU shall be installed within an environmentally controlled environment (cabinet or inside a building).

The microwave and all appurtenances shall be FCC approved under FCC Part 101 and shall have an equipment authorization as part of Article 15. The Contractor shall obtain the license in ALDOT's name and bear all cost associated with the license as part of payment for the licensed wireless link. (See additional Contractor responsibilities within the respective Construction Section of this Specification.)

The wireless transceiver assembly shall operate as point-to-point or point-to-multipoint and at the frequency/frequencies as shown on the Plans. The equipment used shall be designed to protect

personnel from exposure to high voltages during equipment operation, adjustments, and maintenance. Radios used for a link(s) shall be of the same brand to accommodate the sharing of the IDU for sparring.

The licensed wireless equipment shall meet the following requirements:

DESCRIPTION	SPECIFICATION
Power and Connectors	120 Vac or 48 Vdc
I/O Interface	4 each - GigE ports (2 each - 10/100/1000 BaseT and 2 each - SFP Optical 1000 BaseX, minimum)
Radio: Annual Availability Frequency Range	 99.999% FCC approved licensed frequency for the project application
Radio Modulation	Hitless and jitterless adaptive modulation with conservative and aggressive configurations
Data Throughput Performance	1000 Mbps or greater true usable throughput as tested by bandwidth speed test unless specified otherwise on the Plans; 1000 Mbps performance shall be under all environmental conditions, times of day, and interference and not be subject to fluctuation below minimum performance standards
Encryption	Hardware based Advanced Encryption Standard (AES) encryption
Operating Temperature: IDU ODU	 23˚F to 131˚F {-5˚C to 55˚C} -27˚F to 131˚F {-33˚C to 55˚C}
Microwave Antenna	High performance antenna with radome at the sizes indicated on the Plans, includes a seven-year manufacturer warranty
Cabling	LMR400 or equivalent or 0.5 in. Heliax Cable

Antenna mounts shall prevent movement in high winds. Mounts shall be accepted by the Engineer prior to ordering.

3. Unlicensed Wireless Network Device.

Unlicensed Wireless Network Device and components shall be a license-exempt Ethernet microwave system which utilizes 2.4 GHz or 5 GHz frequencies. These unlicensed frequencies have no regulating body and will receive no help from authorities regarding interference. Unlicensed Wireless Network Device and components shall be installed at the frequency specified on the Plans and as accepted by the Engineer.

The wireless unlicensed Ethernet radio system shall meet the following requirements:

a. 2.4 GHz and 5 GHz radios supplied shall meet FCC Part 15.247 and Industry Canada (IC) RS-210.
b. 2.4 GHz equipment shall operate between the ranges of 2.400 - 2.483 GHz.
c. 5 GHz equipment shall operate between the ranges of 5.170 - 5.250 GHz and/or 5.725 - 5.875 GHz.
d. Radio shall provide data rates up to 300 Mbps along with the highest industry-established security features available. The radio shall be compatible with high bandwidth, long range industrial application.
e. Radios shall be point-to-point or point-to-multipoint based on Plan details.
f. Radios shall be 802.11ac, backwards compatible with 802.11a/n standard protocols.
g. Time-division multiple access (TDMA) may be allowed for wireless communications based on project bandwidth requirements and acceptance by the Engineer.
h. Radios shall be dual chain (i.e., 2x2 MIMO) or greater.

i. One each 8P8C (a.k.a. type RJ45 “unkeyed”) modular jack port required operating at 10/100/1000 Ethernet.
j. The radios shall also have security equal to the following encryptions: WEP (not allowed), WPA, WPA2 [including AES, Cryptography (CCMP), Temporal Key Integrity Protocol (TKIP) (not allowed), and MAC/RADIUS Authentication].
k. Adaptive modulation: RF link is monitored to automatically adjust the data rate to optimize the maximum link performance.
l. Radios shall support these networking features: Spanning Tree Protocol (STP), DHCP, NTP, SNMP, VLAN, Routing, and Quality of Service (QOS) (802.11e/Wi-Fi Multimedia (WMM)), and Multicasting.
m. Radios shall provide embedded web-based configuration and diagnostic menus and a complete software toolset to assist in design, configuring, monitoring and optimizing the wireless network.
n. Radios shall be manufactured in the United States of North America with 100 percent performance testing over operating temperatures of -22˚F to 140˚F {-30˚C to 60˚C}.
o. Radios may be powered by Powered over Ethernet (PoE) Injector (IEEE 802.3) with surge protection.
p. Integrated antenna shall have a minimum gain of 24 dBi for 5.8 GHz and 11 dBi for 2.4 GHz.
q. Embedded Global Positioning System (GPS) with auto map location.
r. On board alignment tool (External RSSI LED) and/or audible alignment tool.
s. Real time link monitoring.
t. Configuration Manager: Hyper Text Transfer Protocol (HTTP), HTTP Secured (HTTPS) [this is the Department’s preferred method], SNMP, and IP auto discovery; Noise level graph; LAN statics; WLAN statics; Error report; Uptime.
u. Limited warranty period for defects in materials or workmanship under normal use and service for a period of two (2) years from the date of installation.

4. Cellular Modem.

The Cellular Modem system shall consist of these major components: cellular modem and antenna.

The cellular modem shall be a gateway type interface and include as a minimum the following:

a. Supported frequency bands:

Long-Term Evolution (LTE)	1900 MHz (Band 2); Advanced Wireless Services (AWS), 1700 MHz (Band 4); 850 MHz (Band 5); 700 MHz (Band 13); 700 MHz (Band 17); 1900 MHz (Band 25)
Wideband Code-Division Multiple Access (W-CDMA)	2100 MHz (Band 1), 1900 MHz (Band 2), AWS, 1700 MHz (Band 4), 850 MHz (Band 5), 900 MHz (Band 8)

b. Power: shall be 9-36 Vdc using 120 Vac or 12 Vdc power supply.
c. VPN:
   i. IPsec, Generic Routing Encapsulation (GRE) tunneling, and SSL VPN client
   ii. Up to 5 concurrent tunnels
   iii. Port Filtering
d. Network and Routing:
   i. Port Forwarding
   ii. Network Address Translation (NAT)
   iii. Dynamic DNS
e. Security:
   i. LDAP, RADIUS and TACACS+
   ii. DMZ
   iii. MAC Address Filtering
   iv. Inbound and outbound port filtering
f. Host Interfaces:
   i. (2 each) 10/100 Base-T 8P8C (a.k.a. type RJ45 “unkeyed”) Ethernet ports
   ii. USB Micro-B Connector
   iii. RS-232, DE-9 connector
   iv. I/O: 5 each Digital, 4 each Analog, 2 each Relay

g. Application Interfaces:
   i. Transmission Control Protocol (TCP)/IP
   ii. HTTPS
   iii. National Marine Electric Association (NMEA)
   iv. User Data Protocol (UDP)/IP
   v. SNMP (version 3, minimum)
   vi. Trimble ASCII Interface Protocol (TAIP)
   vii. DHCP
   viii. Short Message Service (SMS)
   ix. GPS

h. LED Indicators:
   i. Network
   ii. Activity
   iii. GPS
   iv. Signal
   v. Service
   vi. Power

i. Antenna Connections:

Primary	50 ohm (Ω), Threaded Neill-Concelman (TNC)
GPS	50 ohm (Ω), SubMiniature version A (SMA)
Rx Diversity	50 ohm (Ω), SMA

j. Other:
   i. High-precision GPS receiver
   ii. External Subscriber Identification Module (SIM) card access
   iii. Low Power Mode
   iv. Remote management and configuration
   v. Three (3) year warranty
   vi. Packet Level Diagnostics

k. Standards:
   i. FCC
   ii. MIL-STD-810G Certified

l. Environmental Ratings:
   i. Operating Temperature Range: -22˚F to 158˚F {-30˚C to 70˚C}
   ii. Storage Temperature Range: -40˚F to 185˚F {-40˚C to 85˚C}

m. Software Management.

Software Management shall include remote management and configuration software and the ability to remotely connect to the cellular modem using HTTPS or SSH. For communication purposes, the cellular modem shall be addressable with an alphanumeric URL that is stored on the cellular modem and a free dynamic DNS maintained by the modem manufacturer. The modem shall not require a static IP address for communication purposes.

n. Cellular Modem Antenna.

The Cellular Modem Antenna shall meet the following requirements as a minimum:

DESCRIPTION	SPECIFICATION
Cellular/LTE	rated for same frequencies as modem
GPS	1575.42 - 1602 MHz
Voltage Standing Wave Ratio (VSWR)	< 2.0
Nominal Gain	698 - 896 MHz: 3 dBi; 1710 - 2620 MHz: 4 dBi
Nominal Impedance	50 ohm (Ω)
Polarization	Right hand circular polarization
Terminations	Cell (SMA male); GPS (SMA male)

The Contractor shall provide antenna assemblies complete with all necessary cabling hardware, connectors, and appurtenances that is compatible with the above specified cellular modem as specified within this Specification and as shown on the Plans.

893.05 Camera.

(a) General.

Camera shall be a Closed-Circuit Television (CCTV) camera unit with the following functional requirements:

1. The camera shall be controlled from a computer running the Graphical User Interface (GUI) provided as part of the current version of ALDOT's Intelligent Transportation Systems software applications and manufacturer's software.
2. The camera shall furnish video to the GUI within 3 seconds after the user's execution of the GUI command to display the live video.
3. The camera shall furnish live video at a user defined frames per second.
4. The camera shall furnish live video with a maximum of 3 seconds of latency.
5. The camera shall broadcast user defined text (i.e., name) within 3 seconds after the user's execution of the GUI command.
6. The camera shall broadcast user defined image (i.e., logo) within 3 seconds after the user's execution of the GUI command.
7. The camera shall reset the following features when commanded from the GUI: camera power supply, camera controller, and camera video encoder.
8. The camera shall have assignable user defined block-out zones (e.g., privacy areas).
9. The camera shall provide two (2) simultaneous video streams.

Manufacturer's certification for each camera shall be provided to the Engineer prior to installation to ensure each camera unit has been properly assembled, configured, factory adjusted for color balance, lens tracking, and other configurable items have been set as specified within the Specifications.

The CCTV camera shall meet the following minimum requirements:

DESCRIPTION	SPECIFICATION
Camera Imaging Unit	Digital signal processing (DSP) solid state design
Environmental	Operating: -30°F to 165°F {-34°C to 74°C}, at Relative Humidity 100% NEMA TS2 rated for power, shock and vibration Sustain winds of 110 mph with a 30% wind gusts factor Remain attached to pole for winds up to 160 mph Camera – Standard IEC 60529 rating of IP 67 Optics housing – shall be heated or pressurized with Dry Nitrogen at 5 psi, Powder Coated Aluminum, and meet IEC Standard 60529 rating of IP67
Image Stabilization	Shall have automatic image stabilization
Resolution	1920 x 1080 (16:9 aspect ratio)
Lens Zoom	30X Optical, 4.4 mm to 129 mm (optical), aperture f1.6 (w) f4.6 (t)
Digital Zoom	12x
Mode	Day/Night switchover: day (color) / night (mono), manual or auto
Horizontal Angle of View	63.4 degrees to 2.3 degrees
Focus Distance	0.7 inch (wide angle) to 29.5 inches (telephoto), minimum
Focus	Automatic with manual override by remote command selection
Iris	Automatic with manual override by remote command selection

DESCRIPTION	SPECIFICATION
Sensitivity	0.4 lux at 1/30 sec. (color day); 0.025 lux at 1/2 sec. (color day); 0.04 lux at 1/30 (mono night), 0.0025 lux at 1/2 sec (mono night)
Video Protocols	RSTP/Real-time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP) Interleave, RTP Multicast Open Network Video Interface Forum (ONVIF) Profile S NTCIP 1205 Version 2
Dynamic Range	≥ 80 db
Imager	1/2.8-inch Complementary metal-oxide semiconductor (CMOS) sensor
Camera ID	Programmable text up to 25 characters long, up to 8 elements, American Standard Code for Information Interchange (ASCII) set. Messages – ID characters are white with black border, text height 4% image resolution minimum. Preset messages to include: camera title, preset title, position, compass, sector title, event title, date/time, and alarm/service message. Bitmap (BMP) format logo display. Message/logo positioning can be placed at left, right, top or bottom. ID message capability shall be set, controlled, and edited by remote commands and text entries.
Privacy Zones	8 programmable zones for video blanking
Digital Video	2 simultaneous, independently configurable video output streams Internal H.264 and MJPEG encoding in accordance with ITU-T H.264 standard and ISO/IEC MPEG-4AVC standard (formally ISO/IEC 14496- 10-MPEG-4 Part 10, Advanced Video Coding). UDP. video multicasting. Resolution – 1080p, 720p, D1, CIF or 16:9 accepted equiv. Frame rate – 1 fps to 30 fps (National Television Standards Committee (NTSC)) Video bandwidth – 256 kbps to 8 Mbps
Camera Housing	Powder coated 6061-T6 aluminum (no polymer-based housings allowed except window) Sunshield Dome distortion free clear polycarbonate Stainless steel hardware, anti-seizing non-hardening compound on threads Mounts rated to meet camera weight and wind loads For pressurized housings: Gas-tight connectors; wiring sealed to connector using silicon or potting compound Schrader valve for pressurizing Pressure relief valve

(b) Fixed Camera.

Fixed Camera shall be a Closed-Circuit Television (CCTV) camera unit with the following additional requirements (minimum):

DESCRIPTION	SPECIFICATION
Camera Power	12 Vdc or PoE (IEEE 802.3)
Automatic Gain Control	managed, 0 to 36 dB
Electronic Shutter	Automatic exposure period with manual override by remote command, selection with a range of: 1/6 second to 1/8,000 second

Connections	1 each 8P8C (a.k.a. type RJ45 “unkeyed”) modular jack (digital; NTSC or Phase Alternating Line (PAL))

(c) Positioner Camera.

Positioner Camera shall be a Closed-Circuit Television (CCTV) camera unit with the following additional requirements (minimum):

1. The camera shall include Pan-Tilt-Zoom (PTZ).
2. The camera shall pan within 1 second after the user’s execution of the GUI command.
3. The camera shall be panned between 0 and 360 degrees in a continuous motion while the command is being executed.
4. The camera shall be panned based on the user defined speeds for each on type of camera ranging from 0.1 to 40 degrees per second.
5. The camera shall be tilted within 1 second after the user’s execution of the GUI command.
6. The camera shall be tilted in a continuous motion while the user defined speed command is being executed within the parameters of Type A and Type B cameras, respectively:

CAMERA TYPE	VERTICAL RANGE
Type A Positioner Camera	+90 degrees to -90 degrees
Type B Positioner Camera	+36 degrees to -85 degrees

7. The camera shall zoom within 1 second after the user’s execution of the GUI command to zoom.
8. The camera shall have the following presets: pan, tilt, zoom, and focus.
9. The camera shall take motion within 1 second after the user’s execution of the GUI preset command.
10. Preset return at an accuracy of ± 0.36 degrees at 120 degrees/sec.

The Positioner Camera shall meet the following additional minimum requirements:

DESCRIPTION	SPECIFICATION
Camera Power	115 Vac (plus or minus 10 percent), 50/60 Hz at cabinet. Imaging unit and positioner operate at 24 Vac or 10-28 Vdc; 128W maximum consumption
Automatic Gain Control	managed, 0 to 48 dB
Electronic Shutter	Automatic exposure period with manual override by remote command, selection with a range of: 1/2 second to 1/10,000 second
Presets	Positioner - 32 pan, tilt, zoom, and focus presets
Control	Addressable RS-422, compatible with device-controlling software
Connections	8P8C (a.k.a. type RJ45 “unkeyed”) modular jack port (digital; NTSC or PAL), BNC (analog). EIA RS-232/422/485 (control)
Pan, Tilt, Zoom (PTZ) Unit	Weather proof Gold plated electrical pin connectors Corrosion resistant, maintenance free gears Drive motors: Instantaneous reversing Overload protected User defined (i.e., adjustable) pan/tilt (preset) speeds Braking pan/tilt, non-drifting Adjustable limit switches for pan/tilt

(d) Dome Camera.

Dome Camera shall be a Closed-Circuit Television (CCTV) camera unit with the following additional requirements (minimum):

1. The camera shall include Pan-Tilt-Zoom (PTZ).
2. The camera shall pan within 1 second after the user's execution of the GUI command.
3. The camera shall be panned between 0 and 360 degrees in a continuous motion while the command is being executed.
4. The camera shall be panned based on the user defined speeds up to 240 degrees per second.
5. The camera shall be tilted within 1 second after the user's execution of the GUI command.
6. The camera shall be tilted in a continuous motion while the user defined speed command is being executed from +5 degrees horizontal to -90 degrees (straight down) at 0.1 degrees/sec to 45 degrees/sec.
7. The camera shall zoom within 1 second after the user's execution of the GUI command to zoom.
8. The camera shall have the following presets: pan, tilt, zoom, and focus.
9. The camera shall take motion within 1 second after the user's execution of the GUI preset command.
10. Preset return at an accuracy of ± 0.36 degrees at 120 degrees/sec.

The Dome Camera shall meet the following additional minimum requirements:

DESCRIPTION	SPECIFICATION
Camera Power	115 Vac (plus or minus 10 percent), 50/60 Hz at cabinet. Imaging unit & positioner operate at 24 Vac or 10-28 Vdc; 128W maximum consumption
Automatic Gain Control	managed, 0 to 48 dB
Electronic Shutter	Automatic exposure period with manual override by remote command, selection with a range of: 1/2 second to 1/10,000 second
Presets	32 pan, tilt, zoom, and focus presets
Connections	8P8C (a.k.a. type RJ45 "unkeyed") modular jack port (digital; NTSC or PAL), EIA RS-232/422/485 (control)
Pan, Tilt, Zoom (PTZ) Unit	Weatherproof Gold plated electrical pin connectors Corrosion resistant, maintenance free gears Drive motors: Instantaneous reversing Overload protected User defined (i.e., adjustable) pan/tilt (preset) speeds Braking pan/tilt, non-drifting Adjustable limit switches or stops for pan/tilt

893.06 Vehicle Detection Systems (VDS).

(a) General.

1. Detection Definitions.

Provide a VDS that shall detect vehicle presence for the purpose of data collection to be used for signal actuation, volume counts, and/or travel time calculations. The Contractor shall provide a VDS utilizing one of the following technologies, as shown on the Plans:

a. Radar Vehicle Detection System (RVDS).

A RVDS uses an FCC-certified, low-power microwave radar beam to detect vehicle presence and generate volume, occupancy, and speed data.

b. Magnetometer Vehicle Detection System (MVDS).

A MVDS uses a magnetic detector probe as a transducer that detects vehicle presence by converting changes in the vertical component of the earth's magnetic field to changes in inductance to generate volume, occupancy, and speed data.

c. Bluetooth Data Collection System (BDCS).

A BDCS uses a Bluetooth detector probe to detect vehicle presence through Bluetooth devices to generate volume, travel time, and speed data.

2. Communications.

The VDS shall generate and transmit traffic data either: (1) in serial format using an ALDOT traffic signal cabinet TS1 or TS2 rack card or through a standard EIA RS-232 communication port; or, (2) an Internet Protocol (IP) addressable Ethernet interface for ITS projects. The communication interface to be used for installation shall be as shown on the Plans. The VDS shall be IP addressable and be compatible with the network device requirements of this Specification. All device communication addresses shall be user programmable.

The VDS shall support PPP, PMPP (i.e., polled protocols), and Ethernet protocols. The setup program shall assign an IP address to each detection unit. The VDS shall respond to a polling request from the TMC for traffic data. The vehicle detection unit shall respond with the accumulated traffic parameter measurements from the period since the last request was issued.

The VDS shall store all system configuration and traffic parameter data within internal, nonvolatile memory. The traffic data shall be capable of local and remote transfer by issuing requests from a personal computer (PC) across the communication network connecting the detector and the TMC operator workstation or other computer.

3. Configuration Management.

The VDS, with exception of Bluetooth, shall be provided with computer software that allows an operator to program, operate, and read the current status of all system features and functions using a laptop computer or remote TMC workstation.

The software application shall provide PC display of the detection zones and control of any vehicle detector connected to the network.

The Contractor, using a locally connected laptop computer, shall conduct system setup, calibration, diagnosis, and data retrieval operations. The detection system shall allow its configuration data saved to a laptop computer, server, or TMC operator workstation, which can later transfer the data back to the detection system for reloading.

The Contractor shall be able to use a laptop computer or TMC workstation to edit previously defined detection configurations to permit adjustments to the detection zone's size, placement and sensitivity, and to reprogram the detector's parameters.

The laptop computer and the detection system shall communicate when connected directly by an EIA RS-232 cable or CAT 5E/6/6A cable via 8P8C (a.k.a. type RJ45 "unkeyed") modular jack ports. The software shall allow communication between multiple users and multiple field devices concurrently across the same communication network. Once programmed, no periodic adjustments shall be required to the detection zones unless physical roadway conditions change, such as lane shifts or closures.

4. Electrical Requirements.

The VDS field hardware shall meet the requirements in the FCC's 2005 CFR, Title 47, Part 15. The detector shall not interfere with any existing equipment.

The vehicle detection system's cabinet components shall operate using a nominal input voltage of 120 volts of alternating current (Vac). For any device requiring a source input other than the standard 120 Vac, the Contractor shall supply the appropriate means of conversion. Equipment shall be furnished with the appropriate power and communication cables. Cables shall comply with NEC sizing requirements as presented in the NEC Article 210-19(a), Fine Print Note (FPN) No. 4, and meet all other applicable standards, specifications and local code requirements.

In the event that power to the VDS or any subcomponent is interrupted, the equipment shall automatically recover after power is restored. All programmable system settings shall return to their previous configurations when the system resumes proper operation.

5. Environmental Requirements.

The Contractor shall provide VDS that meet all requirements during and after being subjected to an ambient operating temperature range of -30°F to 165°F {-34°C to 74°C} with a maximum

noncondensing relative humidity as defined in the environmental requirements section of the NEMA TS2 standard.

The VDS manufacturer shall certify that its device has successfully completed environmental testing as defined in the NEMA TS2 standard. Vibration and shock resistance shall meet the requirements of NEMA TS2 Sections 2.1.9 and 2.1.10, respectively. The system components shall comply with the environmental requirements detailed in the NEMA TS2 standard.

The Contractor shall furnish and install an environmentally resistant and tamper-proof sensor enclosure for any detector assembly exposed to the elements. The enclosure shall be environmentally sealed upon installation.

(b) Radar Vehicle Detection System (RVDS).

Radar Vehicle Detection System (RVDS) shall meet the following functional requirements:

1. The RVDS shall be manufactured for side-fire detection.
2. The RVDS shall measure volume, average speed, classification, occupancy, density, headway, gap time, and vehicle presence.
3. The vehicle detection unit shall detect vehicles through all environmental conditions.
4. The RVDS shall provide detection data via RS-232 connection and Ethernet connection.
5. The RVDS shall configure manually for zones. The user shall configure zones by defining zone limits through the Graphical User Interface (GUI).
6. The RVDS shall back up detection zones data in non-volatile memory automatically and manually.
7. The detection zones shall restore automatically if the system is interrupted, manually through a GUI command, and without detection disruption.
8. RVDS shall provide a real-time traffic pattern display to the GUI.
9. The RVDS shall reset specified feature when commanded from the GUI for radar detector power supply.

The RVDS equipment shall also meet the following minimum technical requirements:

DESCRIPTION	SPECIFICATION
Type A Type B	Single beam Dual or multi beam
Radar Detector Power	115 Vac, 60 Hz
Frequency	24.00 to 24.25 GHz
Frequency Tuning	No manual tuning to circuitry
Detection Range	6 to 250 ft. {1.8 to 76.2 m}
Lane Detection	12 lanes
Type A Accuracy: Volume Speed Classification	 97% typical 95% typical 90% typical
Type B Accuracy: Volume Speed Classification	 98% typical 97% typical at 70 mph; 95% typical at 40 mph 90% typical
Communication Ports	Full-Duplex RS-232 with RTS/CTS or Half-duplex RS-485
Firmware Upgrade	Firmware Upgradability over any communication port
Baud Rate	User configurable. Supported Baud Rates: 9600, 19200, 38400, 57600, and 115200 bps.
User Configurable Settings	Baud rate, Response delay, Data push, RS-232 flow control
Interval Data Collected for Each Lane	Sensor ID, Timestamp, Volume, Average Speed, Occupancy, Classification Counts, Speed Bin Counts, Direction Counts, Average Headway, Average Gap, 85th Percentile Speed
Event Data for Each Detection	Sensor ID, Timestamp, Lane Assignment, Speed, Length, Class
Presence Data for Each Lane	Sensor ID, Per-Lane Presence
Vertical Beam Width	50°
Horizontal Beam Width	6°
Maintenance	No cleaning or adjustment necessary, no battery replacement necessary, no recalibration necessary, mean time between failures: 10 years minimum

(c) Magnetometer Vehicle Detection System (MVDS).

Magnetometer Vehicle Detection System (MVDS) shall meet the following functional requirements:

1. The MVDS shall operate with three (3) main parts: in-cabinet data processing unit, access point with antenna(s), and in-road magnetometer vehicle detection unit.
2. The MVDS shall measure volume, occupancy, density, headway, gap time, and presence.
3. The in-road detection unit shall wirelessly transmit vehicle data to the access point. All necessary equipment (e.g., transceivers, receivers, etc.) shall be included as part of the MVDS.
4. The in-road detection unit shall wirelessly receive configuration data from the access point.
5. The in-road detection unit shall communicate through snow, water, ice, concrete, asphalt, and epoxy used to fill in around in-road unit.
6. The MVDS shall provide an output compatible for use with NEMA TS2 controllers, Type 2070 controllers, and Type Advanced Transportation Controller (ATC).

7. The MVDS shall provide detection data via wireless communication from in-road units to the access point and communication from the access point to the in-cabinet unit, wirelessly and wired through EIA RS-485 connection.
8. The in-road units shall sense vehicles within a 3 ft {0.9 m} radius of the in-road unit location.
9. The in-road unit shall recalibrate itself if environmental changes, roadway shifts, and roadway buckles.
10. The MVDS shall configure in-road units manually and into groups for phase designation.
11. The MVDS shall back up detector configurations in internal storage of the in-cabinet unit automatically and manually.
12. The detector configuration shall restore automatically if the system is interrupted, manually through the Graphical User Interface (GUI), and without detection disruption.
13. The MVDS shall provide a real-time traffic pattern display to the GUI.
14. The MVDS shall broadcast fault information on the GUI for power failure, communication errors, and in-road unit low battery.
15. The MVDS shall reset specified features when commanded from the GUI for in-cabinet unit, access point, and in-road unit.

The MVDS equipment shall also meet the following minimum technical requirements:

DESCRIPTION	SPECIFICATION
Detection Area	Each detector shall detect vehicles comparable to that of a 6 ft x 6 ft {1.8 m x 1.8 m} loop
Detector Battery Life	The average lifespan for detector batteries shall be ten (10) years minimum
Detector Battery Type	D cell lithium battery or equivalent
Average Vehicle Count	95% accurate at 500 VPHPL
Communication Ports	8P8C (a.k.a. type RJ45 “unkeyed”) modular jack port, EIA RS-485, Ethernet
Interval (bin) data packet protocol	Shall support: Sensor ID; Timestamp which records year, month, day, hour, minute, and second; Total volumes; Average speed values in either mph or kph; Occupancy in 0.1% increments; Volume in up to eight length-based user-defined vehicle classification bins; Volume in up to 15 user-defined speed bins (bin by speed); Average headway in seconds; Average gap in seconds; 85th percentile speed in either mph or kph
Event (per vehicle) data packet protocol	Shall support: Sensor ID; Timestamp which records year, month, day, hour, minute, second, and millisecond of the time the vehicle left the detection zone; Lane assignment; Speed values in either mph or kph
Real-time true presence data packet protocol	Shall support: Sensor ID; True presence information for each magnetometer being monitored

(d) Bluetooth Data Collection System (BDCS).

Bluetooth Data Collection System (BDCS) shall meet the following functional requirements:

1. The BDCS shall receive media access control (MAC) addresses associated with Bluetooth-enabled devices utilizing either discoverable and/or non-discoverable methods.
2. The BDCS receiver shall identify unique MAC addresses associated with Bluetooth-enabled electronic devices.
3. The BDCS shall compare unique MAC addresses associated with Bluetooth-enabled electronic devices.

4. The BDCS shall temporarily store identification information to use for matching for the purposes of travel time.
5. The BDCS shall be configured through the GUI for setting the duration of time to temporarily store identification formation for matching.
6. The BDCS shall transmit travel-time based on pairing of BDCS sensor locations.
7. The BDCS shall be configured through the GUI for setting pairings for travel time.
8. Travel time pairings shall be configurable for two detectors to be paired for beginning and end designations.
9. Travel time pairings shall be configurable for more than two detectors to be paired for beginning and end designations with the intermediate detectors having to be triggered as a logical parameter check for the match completion (i.e., not a sum of pairings)
10. The BDCS shall transmit average speed based on pairings of BDCS sensor locations.
11. The BDCS shall be configured through the GUI for setting pairings for average speed.
12. Average speed pairings shall be configurable for more than two detectors to be paired for beginning and end designations with the intermediate detectors having to be triggered as a logical parameter check for the match completion (i.e., not a sum of pairings).
13. The BDCS sensor shall maintain MAC addresses unlinked to a specific person.
14. The BDCS shall transfer data using an Ethernet based connection.
15. The BDCS shall detect within a minimum radius of 250 ft. without obstructions.
16. The BDCS detection range shall be adjusted by user configurable transmit power.

The BDCS equipment shall also meet the following minimum technical requirements:

DESCRIPTION	SPECIFICATION
Detector ID	Each detector shall have a dedicated IP address
Power Supply (Type to be as shown on the Plans)	Detectors shall support power via: • 110-220 Vac (supports direct connection or power supply, PoE (IEEE 802.3)) • 10-48 Vdc (supports 85W solar powered unit with gel sealed battery, PoE (IEEE 802.3))
Updates	The server shall be capable of receiving patches and updates
Communications (Type to be as shown on the Plans)	Ethernet 10/100 BaseT (static or DHCP IP address) LTE cellular connection
Bluetooth Sensing	Data shall be retrieved for both MAC addresses and/or Bluetooth unit heartbeats.
Detection Information	12 characters of the MAC address shall be detected for discoverable Bluetooth signals 6 characters of the MAC address shall be detected for non-discoverable Bluetooth signals, if included
Bluetooth	2.4 GHz Demodulator
Antennae	2 dBi Omni (discoverable Bluetooth detector) 2 dBi Omni (non-discoverable Bluetooth detector, if included) LTE – MIMO Receive Diversity
Detector Memory	On board 4GB Micro-SD card up to 1 year of storage
Processor	Real time microcontroller
Bluetooth	v4.1

893.07 Dynamic Message Sign (DMS).

(a) General.

1. DMS Descriptions.

The Contractor shall provide and install a Dynamic Message Sign (DMS) that shall display a user defined changeable message for the purpose of relaying traffic, hazard, emergency, or other information to the travelling public. ALDOT uses the following DMS styles:

a. Walk-In DMS.

A Walk-In DMS uses a permanently mounted dynamic message board to display information and can be entered to perform routine maintenance and repair.

b. Front Access DMS.

Front Access DMS uses a permanently mounted dynamic message board to display information and can be accessed for routine maintenance and repair through opening sections of the message board face.

c. Dedicated DMS.

A Dedicated DMS uses a permanently mounted dynamic message board to display travel time information. The Dedicated DMS is mounted to a standard retroreflective sign which explains the dynamic information shown on the Dedicated DMS.

2. Manufacturer Compliance.

The DMS manufacturer is required to fully comply with this Specification. The Contractor shall provide a compliant first-draft submittal and DMS equipment that complies with this Specification. The Department reserves the right to independently verify the compliance of all delivered DMS products prior to acceptance and payment.

The DMS Manufacturer shall be ISO 9001 Certified or ISO 9001 Compliant as determined by the Engineer.

3. Material and Process Standards.

All materials furnished, assembled, fabricated or installed under this item shall be new, corrosion resistant and in strict accordance with the Specifications and as shown on the Plans.

Aluminum for fabricated items shall conform to the requirements of **Section 891**, unless otherwise stated herein. Aluminum DMS housings and control equipment cabinets shall be fabricated, welded or chemically bonded and inspected in accordance with the requirements of the ANSI/American Welding Society (AWS) D1.2 Structural Welding Code-Aluminum (latest version). [See **Item 893.07(a)4, *"Sign Housing"*** for special material submittal requirements regarding welders and welding inspectors.]

DMS shall meet the requirements of NEMA TS4 "*Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*". DMSs are classified by the type of sign display and the type of mechanical construction. Provide full-color and full-matrix signs as shown on the Plans and required within the Specifications. DMS shall use only equipment and components which meet the minimum requirements specified within the Specifications.

The front of the DMS housing shall have either a flat black matte finish or a semi-gloss black polyvinylidene fluoride (PVDF) coating. This finish coating shall withstand extreme weather conditions and prevent chalking.

4. Sign Housing.

a. General.

Structural mounting hardware (nuts, bolts, washers, etc.) shall be stainless steel and shall be appropriately sized for their application.

The DMS housing shall be fabricated, welded and inspected in accordance with the requirements of ANSI/AWS D1.2 Structural Welding Code-Aluminum. Compliance with this requirement shall include, but is not limited to:

i. The DMS manufacturer's submittal shall contain a copy of the manufacturer's certified welding procedures.

ii. All manufacturing personnel who perform welding on the DMS housing shall be certified to AWS D1.2 for all weld types required for housing fabrication. The DMS manufacturer's submittal shall contain a copy of each welder's certification.

iii. All personnel who perform welding inspection on the DMS housing shall be certified to AWS D1.2. The DMS manufacturer's submittal shall contain a copy of each Certified Welding Inspector's certification, along with their phone number and address.

iv. All DMS housing welding shall be inspected on a daily basis by a Certified Welding Inspector (CWI), who shall complete daily written reports on DMS welding progress, housing weld integrity, and any corrective action taken. These reports shall be archived by the DMS manufacturer and shall be available for immediate review upon request by the Engineer.

b. DMS Housing Test.

The DMS housing, including its front face panels, shall pass the NEMA hose-down test as described in the latest edition of NEMA Standards Publication 250. However, the spray angle need not be more than 75° from straight down.

c. Professional Engineer Certification of DMS Housing Structural Design.

The DMS housing, structural framing, face covering, and mounting members shall be designed to comply with the requirements of AASHTO's "*Standard Specifications for Structural* Supports *for Highway Signs, Luminaries and Traffic Signals, 2009 Edition*" regarding wind loads and gust factors. The DMS housing must also withstand a front face ice load as defined in same AASHTO document. The DMS housing design shall be certified and sealed by a Professional Engineer registered in the State of Alabama.

d. Ventilation and Heater.

The DMS housing shall be provided with the necessary louvered vents positioned such that vehicle exhaust fume intrusion into the sign housing is minimized while the housing is provided with sufficient ventilation to maintain the thermostat temperature settings. Provide fans, thermostatically and parallel timer switch controlled, to pull warm air out of the sign housing to support the venting of the heat within the sign housing to the extent that an interior temperature of no more than 130°F {54°C} is reached with a 120°F {49°C} direct sunlight generated ambient temperature with the access door closed and locked. Documentation of the design calculations to support the performance of the ventilation and heating systems shall be included with the DMS material submittal and delivered to the Engineer. (Similarly, effective positive-pressure ventilation and heating system may be used but must be submitted via an exception letter to the Engineer for review and approval. If approved, this positive-pressure ventilation system must meet same heating and cooling levels and comparable features as those obtained with above ventilation and heating system.)

Use replaceable waterproof washable dust filters across all vents and position them such that when in place a secure dust tight joint exists between the filter and the housing. Install fans in protected fan openings within the DMS housing such that moisture, dust, vehicle exhaust fumes, or insects or birds will not enter the fan opening.

Control the ventilation fan and heater by thermostats adjustable to operate the fan between the range of 70°F to 130°F {20°C to 54°C} and a separate heater thermostat adjustable between the range 30°F to 80°F {-1°C to 27°C}. The on-off temperature delta of the thermostats shall be nominally 3°F {1.7°C}. Verify that the current rating of the thermostats is no less than 200 percent of the respective controlled equipment. Provide a two (2) hour timed-on fan switch for operation of the fans by maintenance personnel that, when placed in the on position will turn on the fans for a period of two hours. Turning the switch into the off position then back on shall reset the timer to two more hours from the off-on cycle of the switch. Install device across the thermostat and switch contacts that will prevent electromagnetic interference being generated with the opening or closing of the thermostat contacts under electrical load.

If required, provide a heating system and thermal insulation to keep condensation on critical elements to a minimum or to maintain performance on temperature sensitive items.

The DMS environmental control system shall also provide the following:

i. The operational status of the fans shall be automatically tested once a day and tested on command from the central controller or laptop computer. The testing of the fan units shall be via solid state airflow sensors mounted within the duct system measuring air flow or the lack thereof. Any lack of flow alarms will cause an error message to be sent to the central controller or laptop computer when the sign controller is polled by the central controller or laptop computer.

ii. All ductwork that impedes access to any sign components shall be easily removable, without tools, for servicing of these components.

iii. All ductwork shall be 0.040-inch minimum aluminum and shall be designed to be extremely efficient with minimal pressure drop throughout the system.

iv. The temperature reading and humidity readings from the sensors shall be continuously measured and monitored by the sign controller. A temperature or humidity reading greater than a user selectable critical temperature shall cause the sign to take action such as the turning on of additional fan units, the turning on of the pixel board heat strips, an automated combination of the two functions or in extreme cases, the sign to go to blank and the sign controller shall report this error message to the central controller.

v. The LED modules and electronic equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the sign controller.

e. Outdoor Ambient Light and Temperature Sensor System.

Sensors, which measure outdoor ambient light levels and the outdoor ambient temperature at the DMS site, shall be mounted to the DMS housing walls. The system shall consist of three (3) commercially available photo-electric sensors and one (1) temperature sensor. Photoelectric sensors shall each have a minimum photo-sensitive area of 0.25 square inches, and sensor output shall be reported to the DMS Field Controller. Temperature sensor output shall also be reported to the DMS Field Controller. Two of the photoelectric sensors shall be placed such that they measure ambient light levels striking the front and rear of the DMS housing, and the third photoelectric sensor shall face the ground. The temperature sensor shall be placed such that it is never in direct contact with sunlight.

Use photoelectric sensors capable of being continually exposed to direct sunlight without impairment of performance of the sensors.

The photoelectric sensor shall be internally read by the DMS dimming system. The dimming system shall read each of the 255 photoelectric sensor levels. The DMS dimming system shall transmit the read value to the DMS ground mounted controller for distribution to the central system. When the DMS is operating in local mode control, the dimming of the DMS display shall be consistent with the ambient light sensed and the dimming system shall command the display into one (1) of three (3) configurable display intensity levels.

Sense the ambient illumination level by orienting and optimizing the system of three photovoltaic sensors in the following manner to sense the ambient illumination level:

- Photoelectric sensor 1 - Northern sky (or toward rear of sign)
- Photoelectric sensor 2 - Facing towards oncoming traffic (upstream or front of sign)
- Photoelectric sensor 3 - Facing down to the ground (or may face down from bottom of sign)

The actual orientation of these minimum three photoelectric sensors should be as recommended by the manufacturer and as approved by the Engineer.

5. DMS Control Functional Requirements.

a. DMS Control.

All project DMS shall operate from a remote sign control computer, referred to as a Field Controller, which receives instructions remotely via:

i. Remotely via wireless or fiber optic communications from the Central Software

ii. Locally via direct laptop computer connection (RS-232) to the Field Controller (Laptop connection shall be possible at the Field Controller within the housing or at the electronics remote access cabinet mounted on the sign structure itself at ground level.)

iii. Via other local control inputs as described within the Specification

The DMS shall continue to display the current message in the event of communication errors and Field Controller lock-up.

The DMS shall display the current message upon restoration of power.

b. Modes of Operation.

All project DMS shall be able to display static messages, flashing messages, or multiple-frame messages, as described below:

- *Static Message* – The selected message shall be displayed continuously on the sign face until the Field Controller blanks the sign or affects the display of another message.

- *Flashing Message* – All or part of a message shall be displayed and blanked alternately at rates from as fast as three (3) flashes per second to as slow as one (1) flash per 10 seconds. Flash rate shall be programmable in increments of 0.1 seconds. In the flashing mode, message display time shall equal message off time.
- *Multiple-Frame Messages* – The selected message shall consist of up to three different frames, with each frame containing up to three lines of information. The display time of each message frame shall be individually controllable in durations of 0.5 seconds or greater and shall be programmable in increments of 0.1 seconds.

6. Display Requirements.

a. Alphanumeric Characters.

All project signs shall display a message composed of any combination of alphanumeric character fonts and punctuation. This shall minimally include the following character fonts and shapes:

i. "A" through "Z" – all as upper case letters, having a vertical height of seven (7) pixels and higher

ii. "0" through "9" as decimal digits, having a vertical height of seven (7) pixels and higher

iii. A blank or space

iv. Punctuation marks as follows . , ! ? - ' ' " " ( )

v. Special characters as follows # & * + < >

b. Multiple Font Styles.

All project signs shall display alphanumeric character fonts having the following configurations.

The LED DMS shall enable the display of text, consisting of a string of alphanumeric and other characters. The approximate size of the sign shall be as shown on the Plans. Each character shall be formed by a matrix of luminous pixels. The supported fonts shall also meet the latest MUTCD font and pixel requirements.

c. Line and Character Spacing.

Signs shall display all the fonts listed herein with the following inter-character spacing:

i. Single-stroke fonts shall be displayable with two-pixel spacing,

ii. Double-stroke fonts shall be displayable with two-pixel and three-pixel spacing, and

iii. The inter-character pixel spacing for the downloadable fonts is user-selected per NTCIP

7. Diagnostic and Status Features.

The functional status of the DMS communications and major DMS components shall be reportable to the DMS Central Software and displayable on the Central Computer monitor. This shall include:

a. Field Controller Communications – as "normal" or "failed".

b. DMS *Site Power* – including the name of power supply, status (e.g., no error, power fail, voltage out of spec, or current out of spec) and type.

c. DMS Display Status – as {name of message being displayed}, "off", or "disabled due to overheating".

d. DMS Display *Status* shall include: When the sign controller is polled or a message is downloaded from the central controller or laptop computer, each pixel in the sign shall be read and its current state (full on, half on, or off), for the current displayed message, shall be returned to the central controller. This will allow the central controller or laptop computer to show the actual message that is visibly displayed on the sign on an individual pixel basis in a WYSIWYG

(What-You-See-Is-What-You-Get) format. This pixel status read shall not affect the displayed message in any way.

e. *LED* Intensity *Level* – the percentage of the "*Maximum Pulse Width Modulation (PWM) Level*" which is either automatically selected by the Field Controller or is manually selected by a Central Software operator.

f. *LED* Intensity *Control Method* – as "automatic" or "manual".

g. *LED* Pixel *Status* – displayed upon operator request, in a bit-map graphic format – "OK", "Stuck at full on", "Stuck at full off", "Stuck at half on", "Stuck at half off".

h. *LED* Pixel *Failure* – as type of test run, pixel location, error type (e.g., stuck on, color error, mechanical error, stuck off, or partial error).

i. Regulated *DC Power Supply Output* – as "normal", "failed", or "Low".

j. *Internal DMS Temperature* – LED pixel board temperature as measured by two internal sensors – presentable in degrees F and C.

k. *Ambient DMS Site Temperature* – outdoor air temperature as measured by an external temperature sensor – presentable in degrees F and C.

l. DMS Environmental Control Fan Status – as "on", "off", or "failed".

m. Additional status and diagnostic information as specified within this Section.

8. Response to Errors.

In the event of communication errors or a Field Controller lock-up, the DMS shall continue to display the current message. In the event of a power failure, the DMS shall display the current message upon restoration of power. All communications and/or power failures shall be dealt with as defined within the parameters of Section 3.5.2.3.5 of NTCIP 1203 (v02.39), "*Configure Event-Based Message Activation*".

9. Transient Protection.

DMS and Field Controller signal and power inputs shall be protected from electrical spikes and transients, as described herein:

a. AC power for all equipment shall be protected at the load center inside the control equipment cabinet. A parallel-connection surge suppresser, rated for a minimum surge of 10kA, shall be connected to the load center in a manner which protects the load center and the equipment it feeds.

b. AC power for control equipment, such as the Field Controller and communication device (Comm Device), shall be further protected by the use of a series-connected surge suppresser capable of passing 15 amperes of current. This device shall conform to the following requirements:

   i. withstand a peak 20,000 ampere surge current for an 8 x 20 microsecond wave form;

   ii. 20 minimum peak surge occurrences;

   iii. clamp at 20,000 amperes, 340 volts, maximum;

   iv. maximum continuous operating current of 15 amperes at 120 Vac, 60 Hz;

   v. series inductance of 200 microhenrys (μH), nominal;

   vi. temperature range of -40°F to 185°F {-40°C to 85°C};

   vii. approximate dimensions of 3 inches wide x 5 inches long x 2 inches high; and,

   viii. this device shall be UL 1149 recognized.

c. RS-485 communication lines between the Field Controller and the LED driver circuits shall be protected by avalanche diodes rated for 11.5 Volts at 10 amps and 14 Volts at 70 amps.

d. RS-232 and RS-485 communication ports in the Field Controller shall be protected by avalanche diodes connected between each signal line and ground.

e. RS-485 photo and temperature sensor communication ports in the control equipment shall be protected by avalanche diodes connected between each signal line and ground.

f. Incoming wireless communication links shall be protected by a series/parallel two-stage suppression device that provides a 200-volt clamp.

g. Digital input and output lines from the DMS to the control equipment shall be protected at the control equipment by optically-isolated input and output modules, or optically-isolated solid-state relays.

i. Inputs shall include but shall not be limited to: DMS regulated power supply diagnostics and the AC power failure alarm.

ii. Outputs shall include but shall not be limited to: cooling fan and defog/defrost fan control.

10. Sign Display and Visibility.

a. DMS Housing Alignment.

The angular alignment of the sign housing shall be static in the vertical direction.

b. Display Visibility.

The sign display shall be clearly visible and legible from distances between 170 ft. and 900 ft. {52 m and 270 m} under normal freeway operating conditions. The luminous intensity of the pixel shall not decrease more than 50 percent when viewed at an angle of ± 7.5 degrees for freeway signs and ± 15 degrees for arterial signs when centered about the optical axis and perpendicular to the surface of the display.

The luminance level (or luminous intensity level) for different elements cannot vary by more than 10 percent of the mean output of all the elements. The contrast ratio shall be within the following ranges:

EXTERNAL ILLUMINANCE (LUX)	CONTRAST RATIO
40,000	7 to 50
20,000	7 to 50
10,000	7 to 50
4,000	7 to 50
400	7 to 50
40	15 to 100

The contrast ratio is to be calculated as follows:

Contrast Ratio = (LA - LB)/LB

where:

LA is measured intensity resulting from the Active Test Area Under Illumination; and,

LB is measured intensity resulting from the Inactive Test Area Under Illumination.

c. Text Size.

When the sign displays text, the DMS shall display text in appropriate sizes and proportions to allow for sufficient sight distance. In locations with speed limits of 45 mph or higher, letter heights of 18 inches minimum shall be used. In locations with speed limits of less than 45 mph, letter height of 12 inches minimum shall be used.

Text characters on full-matrix signs shall conform to ALDOT's current font library used with ALDOT's Intelligent Transportation Systems software applications.

11. ITS Cabinet.

DMS components not contained within the DMS housing shall be installed within an ITS Cabinet as specified within this Specification of the type and location as shown on the Plans.

12. DMS Field Controller.

Each DMS shall include an associated Field Controller, which shall be installed within the sign housing itself or in an ITS Cabinet mounted on the sign structure.

DMS Field Controller shall be either a Type 2070L controller or a proprietary controller. Both controller types shall be fully programmed with the proper NTCIP protocols.

If a proprietary controller is to be utilized, the DMS sign manufacturer shall be required to enter into a firm price supply contract with ALDOT for no less than five years at an end cost to ALDOT of no more than 80% of the most current State Contract Pricing for a standard Model 2070L controller.

The DMS Field Controller shall conform to the following requirements:

a. Characteristics.

i. Each Field Controller shall be a microprocessor-based integral unit containing its own regulated DC power supply.

ii. Field Controller shall be housed in its own environmentally-resistant, durable, non-corrosive enclosure.

iii. Field Controller enclosure shall: easily fit inside the control equipment cabinet; not exceed volume of five cubic feet; and occupies no more than 1.5 feet of vertical rack space.

iv. Maximum weight of 25 pounds, including its enclosure.

v. Field Controller shall operate successfully throughout a temperature range of -22°F to 185°F {-30°C to 85°C}, and it shall otherwise conform to the environmental standards outlined in NEMA TS2, Section 2.

vi. Within the housing shall reside a remote fiber optic transceiver or a wireless transceiver as shown on the Plans.

vii. Only one sign controller shall be used in each sign. No intermediate control device shall be used.

viii. Field Controller hardware and software shall support all DMS communication, control, and diagnostic features as listed herein, as well as those features listed in the DMS and Central Software requirements.

ix. Field Controller hardware and software shall permit communication with the Central Computer in either of the following modes, which shall be user selectable:

- *Polled Multi-Drop Operation* in which the Field Controller informs the Central Computer of its current status, in response to a periodic automatic query from the Central Computer; or,
- *Event-Driven Operation* in which the Field Controller responds to operator- initiated queries from the Central Computer, and it also calls the Central Computer as required herein.

b. Memory.

DMS Field Controller shall have both permanent and changeable memory. Permanent memory shall be in the form of flash-PROM integrated circuits, or latest technology being utilized as approved by the Engineer, and shall contain the executable Field Controller software. Changeable memory shall be in the form of non-volatile changeable solid-state memory integrated circuit, or utilize latest technology as approved by the Engineer, and shall retain the data in memory for a minimum of one year following a power failure. The changeable memory shall contain the library of messages, the message display schedule and programmable operating parameters. Message storage requirements and attributes shall be as detailed within this Specification. Each message shall have the capability to be defined and stored as a six-frame message.

c. NTCIP Conformance and Management Information Base (MIB).

The DMS Field Controller shall implement an NTCIP protocol stack that is based on the NTCIP Object Definitions for Dynamic Message Signs and Class B profile (NTCIP 1201, NTCIP 1203, NTCIP 2001, NTCIP 2101, NTCIP 2104, NTCIP 2201, NTCIP 2202, and NTCIP 2301). All communication will be made using either SNMP or Simple Mail Transfer Protocol (SMTP) to retrieve and/or update the configuration of the DMS controller. Furthermore, if the DMS Field Controller is required to generate a response to the SNMP/SMTP request, then it should send the response to the requestor within five (5) seconds of receiving the request.

NTCIP Conformance and MIB Objects shall meet the following functional requirements:

i. The DMS Field Controller shall implement an NTCIP protocol stack based on the NTCIP Object Definitions for DMS and Class B profile.

ii. The configuration of the DMS Field Controller shall update using communication via SNMP and SMTP.

iii. When the DMS Field Controller is required to generate a response to the SNMP/SMTP request, the controller shall send the response to the requestor within five (5) seconds of receiving the request.

d. Data Transmission Requirements.

Each Field Controller shall contain two EIA/TIA RS-232E communication ports:

i. one for remote wireless or fiber optic communications; and,

ii. one for local communication with a laptop computer (using 10/100 BaseT Ethernet port).

Both ports shall be capable of operation at baud rates of 9,600 to 56,000 bits per second or greater. The exact baud rate used shall be user selectable. The Contractor shall install a communications Comm Device as shown on the Plans and shall connect the Comm Device/transceiver to the EIA/TIA RS-232E port and communications device.

e. Clock.

Field Controller shall contain a computer-readable time-of-year clock that has a lithium battery backup. The battery shall keep the clock operating properly for at least ten (10) years without external power, and the clock shall automatically adjust for daylight savings time and leap year through hardware or software or a combination of both. The clock shall be set by the Field Controller's microprocessor, and it shall be accurate to within one (1) minute per month.

f. Password.

The user shall be prompted to enter a password which shall be stored and verified by the Field Controller. The password shall not be echoed on the operator interface when entered by the user. The Field Controller shall be able to store a minimum of three (3) user passwords. Initial access passwords shall be installed by the Contractor as required by the Engineer.

13. Field Controller Software.

The Field Controller shall instruct the LED driver circuitry in a manner which causes the desired message to be displayed on the DMS. At a minimum, signs shall be able to display the alphanumeric character fonts described within the Specification. Software shall handle such details as centering text on a display line, right justification, left justification, and legible spacing of letters and words. Software shall include a mechanism to allow the selection of a particular font style (character width and single-stroke vs. double-stroke, etc.).

The software shall support a flashing feature and the alternating between frames of a multiple-frame message as described within the Specification. Software shall be designed to provide a default value for each display parameter supported.

a. Message Selection.

In the absence of instructions to the contrary from the Central Software, the Field Controller shall implement a message selected from those stored in its memory, based upon date and time as specified by a message schedule feature.

Display of a scheduled message may be overridden by instructions sent from a Central Software operator. A Central Computer or laptop computer shall be able to cause the Field Controller to implement a particular message selected from those stored in its memory, or a new message entered via the Central Software. The Central Software shall be able to edit or completely replace a message stored in the Field Controller's memory or revise the message schedule. In addition, it shall be able to cause the Field Controller to report its schedule or the text of any message stored in its memory.

Software shall incorporate fail-safe procedures to check messages received and shall not change a message stored in memory, the message currently displayed on the sign, the schedule stored in memory, or the current time unless the new message is correctly received.

Normally, a displayed message shall remain on the sign until either a command to change the current message or the schedule in the Field Controller's memory indicates that it is time for a different message. However, it shall be possible to confer a "*priority*" status onto any message, and a command to display a priority message shall overwrite any non-priority message being displayed.

b. LED Intensity Control System.

The sign controller shall monitor the photocell circuits in the sign and convert the measured light intensity into the desired pixel brightness. The photo circuit readings shall be correlated with a brightness table in the sign controller. The brightness table shall have a minimum of 255 brightness levels. Automatic adjustment of the LED driving waveform duty cycle shall occur in small enough increments so that brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. The brightness table in each individual sign controller shall be adjustable from the central controller and can be customized according to the requirements of the installation site. Each sign shall have its own, independent brightness table.

Brightness shall be manually settable from the front panel of the controller and remotely from the central computer in 1% increments.

The LED intensity control system shall conform to the following requirements:

i. The DMS shall contain three (3) photoelectric sensors, which shall be provided and installed as described within the Specification.

ii. Manual and automatic intensity control modes shall be provided in a manner which enables the user to select the desired mode of operation, although the typical control mode shall be "*automatic*".

iii. Automatic intensity control shall select one of at least sixteen LED intensity levels based on the sensed ambient light. The threshold points for each intensity levels shall be user programmable. LED intensity levels shall be available in 1% increments and in a range of 1% to 100% of maximum display intensity.

iv. Central Software shall contain a feature which enables the user to set a maximum usable intensity threshold, which is a percentage of the absolute maximum possible intensity. This shall be for the purpose of providing intensity headroom, for future years when the LED's begin to degrade. Daily LED intensity levels, selected via both automatic and manual control, shall be selectable from a range of 1% to 100% of this maximum intensity value. At the time of DMS delivery, this maximum intensity value shall be set to 67%.

v. Manual intensity control shall be achievable both locally and remotely. Local control shall be with a laptop computer connected to the RS-232 port furnished in the Field Controller. Remote control shall be achieved by calling the Field Controller with a Central (remote) Computer.

c. Interference.

The DMS intensity control circuits and power system shall utilize electrical devices to minimize radio frequency interference (RFI) noise generated by the DMS on the power line, as well as noise radiated by the DMS circuitry.

d. Communications.

The Field Controller shall be able to communicate with the Central Computer via the remote-control port in either of two ways: polled multi-drop operation or event-driven direct operation.

In polled multi-drop operation, there is constant communication between each Field Controller and the Central Computer. Several Field Controllers may be on the same communication channel, with each controller assigned a unique identification (ID) number. ID numbers for controllers shall conform to the NTCIP requirements for address numbers as indicated in this Specification, and a Field Controller shall only respond to messages labeled with its ID or to the broadcast address ID. In the polled multi-drop mode, Field Controllers never initiate communication, but merely transmit their responses to commands or queries from the Central Computer. The Central Computer queries each Field Controller frequently about its current status information.

Each sign shall have a unique ID number, which the Region/Area or Central TMC Computer selects when it wants to issue a command or check on the status of the sign. The Field Controller shall also be able to call the Central Computer whenever it detects restoration of AC power at its DMS site and/or the internal DMS temperature exceeds the programmed safety limit. If the Central Computer's line is busy, the Field Controller shall keep trying at intervals selectable by the operator until communication is established. Once it connects with the Central Computer, the Field Controller shall transmit a status message that includes its identifying number. The Field Controller shall automatically disconnect dial-up communications within five (5) minutes if communication from the Central Computer is not detected.

Upon any status changes initiated either remotely or locally to the DMS Field Controller, the Field Controller shall automatically update the Central Computer.

The Field Controller shall be configured such that if one communication mode is operational (multi-drop vs. wireless), then the functionality of the other mode is disabled.

With either communication mode, it shall be possible for a maintenance technician to connect a laptop computer to the Field Controller's local RS-232 port and carry out all DMS control and diagnostic operations that could be carried out by the Central Computer. However, local laptop control capability shall be limited to only the DMS which is directly connected to that Field Controller.

e. Controller ID.

An 8-byte identification (ID) code shall be assignable to each Field Controller.

f. LED Diagnostic Test Capability.

Upon command from either a remote Central Computer or a locally-connected laptop computer running Central Software, the Field Controller shall test the electrical operation of all LED pixels and determine whether they are operating with: "*normal*" current, "*over*" current (short circuit), or "*under*" current (open circuit). This shall be accomplished via A/D conversion of each pixel's forward current. The alternate method of constant current monitoring may be used. The resulting data shall be communicated to the Central Software using an NTCIP compliant method that can be transmitted according to the NTCIP Class D profile. LED pixel diagnostic data shall be displayable to a system operator as described in ALDOT's Regional Traffic Management Center (RTMC) Standard Operating Procedures Manual.

g. Power Interruptions.

Contents of the Field Controller's memory shall be preserved by battery backup during AC power interruptions and the Controller shall automatically resume operation once AC power is restored. Upon recovering from a power interruption, the Field Controller shall leave the current message on the sign until it receives a command to change it, or until a message change is called for by the sign schedule. The Field Controller shall report to the Central Computer that it has just recovered from a power interruption.

h. DMS Communications Devices.

i. Fiber Optic Data Transceivers.

Fiber Optic Data Transceivers shall be in accordance with **Article 893.04, *"Network Devices"*** and shall be fully compatible with the existing fiber optic network devices and their control and diagnostic bays in Hub and TMC buildings. Network Devices shall be single-mode and RS-232. Fiber optic transceivers shall be mounted within the DMS exterior equipment cabinet mounted on the sign structure itself.

If shown on the Plans, the Contractor shall supply one (1) remote or field fiber optic transceiver and one (1) head-end fiber optic transceiver for each direct connect DMS. These Fiber Optic Data Transceivers both field and head-end shall be paid under their respective pay item number.

ii. Wireless Data Transceivers.

The Wireless Data Transceiver units required on remote signs, those not direct-connected via fiber optic cable, shall be remote data units as supplied by the Department and as indicated on the Plans. These units shall be set up for data transmission, RS-232.

ALDOT shall provide the Contractor with one (1) remote unit per remote sign and one (1) head end unit that has the capability to communicate with a maximum of 30 multiple remote wireless units.

The Contractor shall indicate which DMS will utilize wireless within the material submittal to the Engineer.

14. National Transportation Communications for ITS Protocol (NTCIP) for DMS.

The DMS shall meet the National Transportation Communications for ITS Protocol (NTCIP) requirements as defined within ALDOT's **ITS Test Manual Document No. ITS-035** "*Supplemental Dynamic Message Sign (DMS) NTCIP Requirements*". This Supplemental Specification document may be obtained by contacting ALDOT's Design Bureau – Traffic Engineering Division or Construction Bureau.

Please note that if a Conformance Group is mandatory, then all objects within that group listed as mandatory shall be supported. If the DMS does not support the functionality associated with a

specific object or group of objects, yet still meets ALDOT's minimum requirements, then the device must respond with a noSuchName error response when requests are made for those objects.

The NTCIP Protocol supplied shall be the most recent version/release implemented. The originally supplied version of the NTCIP software supplied with the DMS shall be fully capable of upgrade by the DMS supplier and with no cost to the State.

15. Laptop Computer.

The Contractor shall have a laptop computer for testing that will run the field controller and NTCIP testing software as required within the Specifications. The laptop computer shall remain the property of the Contractor after the completion of all DMS testing.

16. Software Upgrades.

The sign manufacturer shall supply to the Department a statewide license for the unrestricted utilization of internal control and remote sign software contained herein. Furthermore, the sign manufacturer shall supply to the Department all future internal control software upgrades of the originally supplied software version at no cost to the Department.

17. Supporting Structure

Supporting Structure used for mounting the equipment shall conform to the requirements given in Section **718**.

DMS shall be attached to their overhead support structures with aluminum support beams comprised of aluminum alloy 6061-T6. The number of support beams needed and the method of attaching the support beams to the sign housing and the overhead sign support structure shall be as required to conform to the current edition of AASHTO's "*Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*" and all other structural requirements specified for this contract. The support beam attachment shall also be certified by a Professional Engineer in accordance with **Section 718**.

Where overhead support structures extend over both directions of a roadway, these structures shall be designed to accommodate future DMS for the other direction along with any necessary walkway, catwalk or access ladder additions. Also, overhead support structures with indicated future DMS on the Plans shall be designed to accommodate these future features along with any necessary walkway, catwalk or access ladder additions. These overhead support structures shall be supplied and installed with a vibration dampener (as approved by the Engineer) in place of the future DMS. The Contractor's design submittal shall include and indicate these items within their respective support structure design computations and drawings.

18. Concrete Foundation

Concrete Foundation used for Supporting Structure shall conform to the requirements given in **Section 718**.

19. Electrical Power Service

Electrical Power Service shall be in accordance with Article 893.13, *"Electrical Power Service and Transformer"*.

(b) Walk-In DMS.

1. General.

a. Housing Service Access.

The Contractor shall provide each Walk-In DMS with a suitable catwalk for service access to the DMS. Include with all Walk-In DMS housings a 4 ft {1.2 m} wide or greater catwalk that extends from the right or left shoulder support structure, as shown on the Plans, to flush with or extending underneath the sign enclosure. Safety rails shall be provided as a part of the catwalk. Provide a catwalk that will support at least 2,000 lbs. {907 kg} with no discernible displacement.

The Walk-In DMS housing and all of its equipment and materials shall be designed and constructed so that all maintenance and repair is performed from within the DMS housing, with the exception of structural members and components thereof.

All Walk-In DMS housings shall have a minimum of 2 ft. 10 in. {86 cm} wide pathway inside the sign housing to allow adequate room for maintenance personnel. There shall be 18 inches {46 cm} of clear area between all equipment along the entire length of the sign housing from the 24 inch {61 cm} walkway up to 6 feet {1.8 m} above the 24 inch {61 cm} walkway. The walkway shall conform to NEMA TS4 Section 3.2.8.2 "*Work Area*" unless otherwise specified within this Specification.

Walk-In DMS housing doors shall be installed on each side of the DMS housing and shall open outward toward the housing's rear wall. DMS housing doors shall be rain-tight/dust-tight and shall

have minimum 2.5 ft. by 6 ft. {0.76 m by 1.8 m} opening. The Walk-In DMS housing doors shall be furnished with a door lock that is keyed to use a Corbin No. 3 key. The door lock shall be a swing cover, plated brass, tumbler type that is designed for outdoor "*no freeze up*" applications. The latching/locking mechanism shall include a handle on the interior of the housing, so that a person with no key and no tools cannot become trapped inside the housing. The door latch system shall be capable of being locked, unlocked, opened, or closed from either the outside or inside of the housing. The Walk-In DMS housing doors shall contain hold-open braces and door stops that allow the door to be held in the full, 90, 45, and 30 degree open positions without the use of tools. The hold-open braces, doors, and hinges shall be designed to withstand a minimum wind speed as defined on the Plans (reference **ALDOT Index Nos. 71001-71002**, **Standard Dwg. No. IHS-710**, "*Wind Velocity Chart for Roadside Signs*") while the door is held in any of these positions.

One of the two Walk-In DMS housing doors will require removable rails to be mounted on the inside of the housing. Rails shall be installed horizontally and spaced vertically every twelve inches to a height of 42 inches {106 cm} above the internal walkway. Rail size shall be as required to prevent a 300 pound {136 kg} person from falling out of the DMS housing, if the doorway is open. Rails shall be attached to the sign housing with stainless steel hardware and designed for removal with simple hand tools.

Rails shall meet OSHA 1910.36 paragraph 6 safety requirements. Prior to DMS installation, the Engineer will advise the Contractor as to which doorway will require rails.

In each Walk-In DMS housing, provide folding step or a similar mechanism to allow a technician to reach the upper interior of the sign during maintenance without the need of a portable device such as a ladder or step stool and which does not interfere with the normal operation of the sign. External repair of the housing and sign face shall be the only items requiring access to the external portions of the housing.

b. Interior Ventilation.

Walk-In DMS housing shall conform to the ventilation requirements of NEMA TS4 Section 3 "*DMS Mechanical Construction*".

c. Interior Lighting and Duplex Receptacles.

The DMS Walk-In housing shall contain interior lighting which conforms to NEMA TS4 Section 3.2.8.3 "*Nighttime Service Lighting*" utilizing UL Listed LED lighting fixtures rated for outdoor use and extreme temperatures.

Comparable fluorescent lighting may be used but must be submitted via an exception letter to the Engineer for review and approval. If approved, this fluorescent lighting must meet same luminance lighting levels as those obtained with above lighting system. Proposed fluorescent light ballasts shall be rated for operation at 0°F {-18°C}.

The light circuit shall be controlled by a manual timer switch having either an adjustable on time of two (2) hours or a four hour timer with adjustable on time of 15 minute increments; and shall be located on the inside of the housing near the door. The light switch timer shall begin timing a "*lights on*" condition of two hours minimum, but no more than four hours, upon activation of the switch. Turning the switch off and back on will reset the time out to another "*lights on*" cycle from the time of the off-on cycle of the switch. Upon time out of this "*lights on*" period, the switch shall deactivate the interior lighting by disconnecting the 120 Vac ungrounded circuit from the light fixture.

Use a circuit breaker to protect two separate duplex 120V Ground Fault Circuit Interrupter (GFCI) receptacles that are provided on each end of the sign case for the use of maintenance personnel. Use receptacles rated for 20 amperes. Each receptacle shall be fed from a 20 ampere nominal 120 Vac circuit.

2. Functional Requirements.

The DMS shall display user defined text and images.

The DMS shall display screens statically, flashing, and as a series of displays.

The DMS shall display screens through user defined actions with the DMS user interface and remotely.

The DMS shall display a test screen when defined by the user for: full display (brightness configured), characters (configured alpha, numeric, and special characters), and patterns (configured flashing, corners).

The DMS shall reset display after power interruption.

The DMS shall operate without interruption with a primary power source.

The DMS shall reset automatically when requested by a user from the DMS user interface and remotely.

3. Technical Specifications.

DMS shall include associated control, diagnostic equipment, wireless or fiber optic communications, LED lights, and power source.

The DMS must meet the requirements of NEMA TS4 "*Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*". A DMS is classified by the type of sign display and the type of mechanical construction.

The Walk-In DMS must meet the mechanical construction requirements of NEMA TS4 Section 3.2.8 "*Walk-In Access DMS*" unless otherwise specified within this Specification.

The **Walk-In DMS** shall meet the following weight, size, power, and display characteristics:

DESCRIPTION	SPECIFICATION	
	Size W-1	**Size W-2**
Weight (maximum):	5000 lbs {2268 kg}	3,500 lbs {1,588 kg}
Housing Dimensions (maximum):		
Width	38 ft {11.6 m}	25 ft {7.6 m}
Height	11 ft {3.4 m}	8 ft {2.5 m}
Depth	5 ft {1.5 m}	4 ft {1.3 m}
Display Dimensions (minimum):		
Width	27 ft {8.2 m}	22.67 ft {6.91 m}
Height	6.25 ft {1.91 m}	6.25 ft {1.91 m}
Power (maximum):		
For signs ≤ 10 characters wide	6,000 W	6,000 W
For signs > 10 characters wide	13,000 W	13,000 W
Display Viewing Angle:	30 degrees	30 degrees
Display Type:	Full Color, Full Matrix	Full Color, Full Matrix
Pixel Spacing:	20 mm	20 mm

(c) Front Access DMS.

1. Functional Requirements.

The DMS shall display user defined text and images.

The DMS shall display screens statically, flashing, and as a series of displays.

The DMS shall display screens through user defined actions with the DMS user interface and remotely.

The DMS shall display a test screen when defined by the user for: full display (brightness configured), characters (configured alpha, numeric, and special characters), and patterns (configured flashing, corners).

The DMS shall reset display after power interruption.

The DMS shall operate without interruption with a primary power source.

The DMS shall reset automatically when requested by a user from the DMS user interface and remotely.

2. Technical Specifications.

DMS shall include associated control, diagnostic equipment, wireless or fiber optic communications, LED lights, and power source.

The DMS must meet the requirements of NEMA TS4 "*Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*". DMS are classified by the type of sign display and the type of mechanical construction.

The Front Access DMS must meet the mechanical construction requirements of NEMA TS4 Sections 3.2.5 "*Front and Rear Access*" and 3.2.6 "*Front Access DMS*" unless otherwise specified within this Specification.

The **Front Access DMS** shall meet the following weight, size, power, and display characteristics:

DESCRIPTION	SPECIFICATION	
	Size FA-1	**Size FA-2**
Weight (maximum):	2,500 lbs {1,134 kg}	3,500 lbs {1,588 kg}
Housing Dimensions (maximum):		
Width	20 ft {6.1 m}	28 ft {8.5 m}
Height	7.5 ft {2.3 m}	8.5 ft {2.6 m}
Depth	2.5 ft {0.8 m}	2.5 ft {0.8 m}
Display Dimensions (minimum):		
Width	16.25 ft {5.04 m}	22.67 ft {6.91 m}
Height	4.16 ft {1.27 m}	6.25 ft {1.91 m}
Power (maximum):		
For signs ≤ 10 characters wide	6,000 W	6,000 W
For signs > 10 characters wide	13,000 W	13,000 W
Display Viewing Angle	30 degrees	30 degrees
Display Type	Full Color, Full Matrix	Full Color, Full Matrix
Pixel Spacing	20 mm	20 mm

(d) Dedicated DMS.

1. Functional Specifications.

The DMS shall display images (as applicable per DMS usage) and user defined text.

The DMS shall display screens statically and flashing.

The DMS shall display screens through user defined actions with the DMS user interface and remotely.

The DMS shall display a test screen when defined by the user.

The DMS shall reset display after power interruption.

The DMS shall operate without interruption with a primary power source.

The DMS shall reset automatically when requested by a user from the DMS user interface and remotely.

2. Technical Specifications.

DMS shall include associated control, diagnostic equipment, wireless or fiber optic communications, LED lights, and power source.

The DMS must meet the requirements of NEMA TS4 "*Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*". DMS are classified by the type of sign display and the type of mechanical construction.

The Dedicated DMS must meet the mechanical construction requirements of NEMA TS4 Sections 3.2.5 "*Front and Rear Access*" and 3.2.6 "*Front Access DMS*" unless otherwise specified within this Specification or shown on the Plans.

The **Dedicated DMS** shall meet the following weight, size, power, and display characteristics:

DESCRIPTION	SPECIFICATION	
	Size D-1 (CSLS)	Size D-2 (CTTS)
Display Dimensions (maximum): Width Height Depth	 As shown on the Plans As shown on the Plans 6 in {15.2 cm}	 As shown on the Plans 2.0 ft {61.0 cm} 6 in {15.2 cm}
Character Height:	As shown on the Plans	18 in {45.7 cm}
Power	120/240 Vac	120/240 Vac
Communications	Ethernet, RS-232	Ethernet, RS-232
Display Viewing Angle	30 degrees	30 degrees
Viewing Distance	1,100 ft	1,100 ft
Display Type	Full Color, Full Matrix	Full Color, Full Matrix

where CSLS is Dedicated Changeable Speed Limit Sign
and CTTS is Dedicated Changeable Travel Time Sign.

DESCRIPTION	SPECIFICATION	
	Size D-3 (DLCS)	Size D-4 (DLCS)
Display Dimensions (maximum): Width Height Depth	 As shown on the Plans 1.5 ft {45.7 cm} 6 in {15.2 cm}	 As shown on the Plans 2.0 ft {61.0 cm} 6 in {15.2 cm}
Character Height:	12 in {30.5 cm}	18 in {45.7 cm}
Power	120/240 Vac	120/240 Vac
Communications	Ethernet, RS-232	Ethernet, RS-232
Display Viewing Angle	30 degrees	30 degrees
Viewing Distance	1,100 ft	1,100 ft
Display Type	Full Color, Full Matrix	Full Color, Full Matrix

where DLCS is Dedicated Lane Control Sign.

893.08 Environmental Sensor.

(a) General.

1. Data Processing Unit.

The Data Processing Unit shall perform any data processing and storage required on the data received from the sensors. Each data record shall include sensor readings of a user-defined time interval of 5 to 60 minutes.

The Data Processing Unit shall be capable of transmitting an alarm in the event of a low power supply, complete power loss, or return to normal operation.

The Data Processing Unit shall be able to transmit alarms for user-defined thresholds for sensor parameters.

The Data Processing Unit shall operate with a minimum of 20 sensors concurrently.

The Data Processing Unit shall process with a minimum of 512 MB RAM.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-22°F to 140°F {-30°C to 60°C} minimum
Housing	Field Hardened
Communications Ports	RS-232, RS-485, Ethernet
Power	24 Vdc, 4 A maximum

2. Communications.

The environmental sensor, whether an individual sensor or working as a system, must be capable of transmitting all collected data. See above table for minimum communication port requirements.

3. Software.

All manufacturer software required to configure and operate the Environmental Sensor system shall be provided.

4. Cabinet.

Any equipment not rated for outdoor use shall be enclosed in a cabinet as specified within the Specifications.

(b) Weather Sensors.

Provide an environmental Weather Sensor that shall provide specified environmental information for the purpose of evaluating environmental conditions for hazards.

1. Air Temperature.

An Air Temperature Sensor determines the temperature of the surrounding environment.

The air temperature sensor shall provide temperature information of the surrounding environment in all weather conditions, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 140˚F {-40˚C to 60˚C}
Accuracy	±0.4˚F (±1.0˚F if < -22˚F) {±0.22˚C}
Housing	Weatherproof International Protection (IP) 66 rated
Humidity Operating Range	5 – 100%

2. Relative Humidity.

A Relative Humidity Sensor uses an industry standard sensor to determine the current relative humidity.

The relative humidity sensor shall provide information on relative humidity of the surrounding environment in all weather conditions and all humidity ranges, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 140˚F {-40˚C to 60˚C}
Accuracy	± 2% Relative Humidity
Housing	Weatherproof IP 66 rated
Power	12 Vdc
Humidity Operating Range	5 - 100%

3. Visibility.

A Visibility Sensor detects low visibility conditions, which might occur during fog or falling precipitation.

The visibility sensor shall provide information on the visibility seen by drivers in all weather conditions, without delay.

The visibility sensor shall measure a two (2) minute sample, providing the average over that interval.

The visibility sensor shall operate with a heated hood to allow continuous operation in all weather conditions.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 140˚F {-40˚C to 60˚C}
Accuracy	± 10%
Range	6,560 ft {2000 m} minimum
Housing	Weatherproof IP 66 rated
Power	12 or 24 Vdc
Signal Output	4 - 20 mA
Sensor Type	Light

4. Precipitation **Rate.**

A Precipitation Rate Sensor determines the current rate of precipitation.

The precipitation rate sensor shall provide information on the rate of precipitation for all precipitation types, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 122˚F {-40˚C to 50˚C}
Precipitation Type	Rain, Snow
Precipitation Quantity (Reproducibility)	> 90% or ± 5%
Housing	Weatherproof IP 66 rated
Power	12 Vdc
Humidity Operating Range	5 - 100%

5. Barometric Pressure.

A Barometric Pressure Sensor uses an industry standard sensor to determine the current barometric pressure.

The barometric pressure sensor shall provide barometric pressure information in all weather conditions, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 140˚F {-40˚C to 60˚C}
Range	850 - 1050 mbar minimum
Accuracy	± 0.5 mbar at 32˚F to 140˚F {0˚C to 40˚C}
Housing	Weatherproof IP 66 rated
Power	12 Vdc
Humidity Operating Range	5 - 100%

6. Wind Speed and Direction.

A Wind Speed and Direction Sensor uses an industry standard sensor to determine the current wind speed and direction.

The wind speed and direction sensor shall provide information on the speed and direction of the wind in all weather conditions, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 140˚F {-40˚C to 60˚C}
Range: Direction Speed	 0 - 359.9 degrees 0 - 75 m/s minimum
Accuracy: Direction Speed	 ±3˚ ± 0.3 m/s
Housing	Weatherproof IP 66 rated
Power	12 Vdc
Humidity Operating Range	5 - 100%

(c) Road Sensors.

1. In Road Pavement Temperature.

An In Road Pavement Temperature Sensor uses an in road unit to determine the temperature of the roadway.

The in road pavement temperature sensor shall provide temperature information of the pavement surrounding the sensor in all weather conditions, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 158˚F {-40˚C to 70˚C}
Temperature Observation Range	-40˚F to 158˚F {-40˚C to 70˚C}
Accuracy	±2˚F {±1.11˚C}

2. Remote Road Pavement **Temperature.**

A Remote Road Pavement Temperature Sensor uses a non-intrusive remote sensor to determine the temperature of the roadway.

The remote pavement temperature sensor shall provide temperature information of the pavement at which the sensor is directed, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 158˚F {-40˚C to 70˚C}
Temperature Observation Range	-40˚F to 158˚F {-40˚C to 70˚C}
Accuracy	±2˚F {±1.11˚C}

3. Pavement Precipitation **Depth.**

A Pavement Precipitation Depth Sensor determines the thickness of ice, water, or snow currently on the roadway.

The pavement precipitation depth sensor shall provide information on the depth of precipitation on the roadway in all weather conditions, without delay.

DESCRIPTION	SPECIFICATION
Temperature Operating Range	-40˚F to 158˚F {-40˚C to 70˚C}
Water Depth Observation Range	0.01 - 0.50 in {0.3 - 12.7 mm}
Water Depth Accuracy	± 0.1 mm
Surface Conditions	Dry, Damp, Wet, Snow, Ice

893.09 Highway Advisory Radio (HAR).

(a) General.

1. HAR Descriptions.

The Contractor shall provide and install a Highway Advisory Radio (HAR) system that shall transmit a user defined changeable message for the purpose of relaying traffic, hazard, emergency, or other information to the public. ALDOT uses the following HAR systems:

a. Permanent HAR.

A Permanent HAR uses a permanently mounted HAR system that transmits a user defined changeable message on AM or FM radio frequencies.

b. Portable HAR.

A Portable HAR uses a portable, trailer mounted, HAR system that transmits a user defined changeable message on low-power AM radio.

c. Configuration and Management.

The HAR shall be configured and managed both locally and remotely.

2. Radio Transmitter.

The Radio Transmitter subsystem shall meet the following requirements:

a. Capability for adjustment of radio frequency (RF) output power and audio input levels through easily accessible controls.

b. A provision for automatic station identification (Automatic ID) shall be included.

3. Digital Recorder/Player.

A Digital Recording Unit shall be provided with the following minimum functional requirements:

a. Digitally record and store messages or audio files.

b. Store a minimum of 250 distinct digital messages or audio files, with variable length messages, which can be recorded, stored, or deleted independently.

c. Provide a minimum of 80 minutes of total recording time.

d. Allow the recording of a message while another message is being played (simultaneous record/playback).

e. Provide capability for message retention (indefinitely) without the use of a battery, in the event main site power is lost.

f. The Digital Recorder/Player shall provide Standard DTMF (dual tone multi frequency) tones as applicable.

g. Audio Frequency Input Impedance: 600 ohm (Ω) and Hi "Z" (The Contractor shall provide a compatible microphone).

h. Modulation Limiter: Built-in 100% peak modulation limiter.

4. Simulcast Synchronization.

a. Each synchronized HAR system shall be equipped with a GPS synchronizer, which shall provide the capability to phase-lock the transmitters to a common reference carrier to minimize heterodyne.

b. The GPS Synchronizer subsystem shall have been successfully tested in conjunction with the transmitter and certified by the FCC in accordance with the provisions of FCC Section No. 90.242.

5. HAR Cabinet.

The cabinet used to contain HAR equipment shall be in accordance with the requirements as specified within the Specifications and as shown on the Plans.

6. Antenna **Subsystem.**

a. Omni-directional, vertically polarized antenna providing high efficiency with low radiation angle performance.

b. Provide an Effective Isotropic Radiated Pattern (EIRP) of 2.0 mV/m @ 1.5Km (0.93 miles) per FCC regulations.

c. Provide an overall VSWR of 1:4 or better with direct feed (without antenna tuner).

d. Antenna shall be constructed from anodized aluminum with adjustable tip to minimize the standing waves.

7. Grounding.

a. The antenna/grounding design shall be provided for each proposed HAR site taking into account local site conditions, soil conditions, antenna type and exact location, along with the ground plane designed.

b. 8 AWG grounding wire shall be installed.

c. The HAR antenna grounding design and design submittal shall be either conducted by or signed off by the HAR equipment manufacturer. The HAR antenna grounding design and submittal package shall include the requirements as specified within this Article and as defined in **Sub-Article 729.03(i)1.c, "*HAR Antenna Grounding*"**.

d. The HAR antenna subsystem shall be provided with an efficient ground plane properly tuned to the operational frequency and ground/soil type and conditions.

e. The grounding subsystem shall consist of a set of horizontal radials of heavy gauge wire or radial loops extending outward from the base of the antenna to ensure proper grounding and performance requirements.

f. An alternate ground system method and configuration may be designed and submitted as part the HAR grounding subsystem design submittal depending on site conditions to the Department for review and approval prior to construction.

g. Regardless of the grounding type, the Contractor shall be responsible for providing a complete grounding subsystem that supports the minimum 4-mile transmission radius system performance as described herein.

h. Antenna mast, or tower sections shall be bonded and grounded through HAR electrode system.

i. Communications cables with metallic sheath and armored cables if used shall be grounded by using appropriate cable grounding kits as recommended by the cable manufacturer.

8. HAR System Software.

In areas where HAR systems exist the Contractor shall integrate new HAR stations with existing HAR server software and hardware.

The HAR software application shall provide centralized operator control and monitoring of dispersed HAR and flashing beacon subsystems with the following minimum features and capabilities:

a. Shall allow the HAR system operator to select, display, schedule, and modify messages, transmit messages, list diagnostic information, and control of HAR field stations via the network.

b. Shall provide for multiple modes of operation as follows: transmitter control, record and monitoring of messages, playing of pre-recorded messages, emergency broadcast mode (live), and National Oceanic and Atmospheric Administration (NOAA) weather radio broadcast when alert is activated.

c. Shall import audio files created externally and log updates.

d. Shall convert typed text into voice that can be used for a clear understandable message.

(b) Permanent HAR.

The Permanent HAR shall also meet the following minimum requirements:

1. broadcast user defined audio;
2. transmit a test broadcast when defined by the user;
3. reset radio transmission after power interruption and when requested by the user;
4. operate without interruption from: hardwired 120 Vac power source, solar panel power source, and battery backup power source; and,
5. operate without interruption from battery backup power source for a duration of three (3) days without charging.

The Permanent HAR shall also meet the following minimum requirements:

DESCRIPTION	SPECIFICATION
Power	120 Vac 12 Vdc Solar 180 Amp Battery Backup providing 3 days of continuous use
Audio Recoding Limit	80 minutes minimum
Transmit Radius	3 - 5 miles {6 - 10 km}
Transmitter	FCC Approved Part 90.242 GPS synchronization
Antenna Height	50 ft maximum
Enclosure	NEMA Type 3R Weatherproof
Broadcast Power	Adjustable up to 10 W
Broadcast Frequency Range	530 - 1700 kHz
Frequency Stability	± 20 Hz
Audio Distortion	< 1.5%, 200 Hz to 3 kHz
Audio Frequency Response	± 3 dB
Noise Level	70 dB maximum below 95% modulation level, 100 Hz to 3 kHz
Modulation	99%, -40 dB to 20 dB
Operating Temperature	-40°F to 85°F {-40°C to 29°C}
Operating Humidity	95% (non-condensing)
Communication Ports	Ethernet, RS 232 Serial, USB Flash Drive

(c) Portable HAR.

The Portable HAR shall also meet the following minimum requirements:

1. broadcast user defined audio;
2. transmit a test broadcast when defined by the user;
3. reset radio transmission after power interruption and when requested by the user;
4. operate without interruption from: solar panel power source and battery backup power source; and,
5. operate without interruption from battery backup power source for a duration of 10 days without charging.

The Portable HAR shall be mounted on a single axle trailer, supporting the antenna, radio, power supply, and other equipment during operation. The Portable HAR shall be towed with a standard ball hitch. The trailer shall be in compliance with federal and local regulations and be roadworthy.

The Portable HAR shall also meet/provide the following requirements:

DESCRIPTION	SPECIFICATION
Power	Primary Solar 12 Vdc, 2 A maximum 200 A Battery providing up to 10 days of continuous use
Audio Recoding Limit	80 minutes minimum
Transmit Radius	3-5 miles {6-10 km}
Transmitter	FCC Approved part 90.242 GPS synchronization
Antenna Height	25 ft maximum
Enclosure	NEMA Type 3R Weatherproof
Broadcast Power	Adjustable up to 10 W
Broadcast Frequency Range	530 - 1700 kHz
Frequency Stability	± 20 Hz
Audio Distortion	< 1.5%, 200 Hz to 3 kHz

Audio Frequency Response	± 3 dB
Noise Level	70 dB maximum below 95% modulation level, 100 Hz to 3 kHz
Modulation	99%, -40 dB to 20 dB
Operating Temperature	-40˚F to 85˚F {-40˚C to 29˚C}
Operating Humidity	95% (non-condensing)
Communication	Digital modem, RS 232 Serial, USB Flash Drive

893.10 Conduit, Conductor, Locate Tone Wire, Messenger, and Warning Tape.

(a) Non-Metallic Conduit.

1. General Non-Metallic Conduit.

Non-Metallic Conduit for ITS and related applications shall be Rigid Non-metallic Conduit (RNC) [i.e. Rigid Polyvinyl Chloride (PVC) conduit, Liquid-tight Flexible Non-metallic Conduit (LFNC), or High Density Polyethylene (HDPE) conduit] as indicated within this Section. All conduits shall be homogeneous and shall have no visible cracks or holes. Non-metallic conduit shall be of the size and type as shown on the Plans.

Non-metallic conduit shall be colored for intended usage as defined by the American Public Works Association (APWA) Uniform Color Codes unless otherwise shown on the Plans or directed by the Engineer. The color codes for underground utilities as adopted by the Department from APWA are as follows:

COLOR	USAGE
Red	Electrical power and lighting
Orange	Telecommunications, alarm or signal lines (ALDOT uses this color for ITS and fiber optics.)
Yellow	Gas, oil, steam, petroleum, or other gaseous or flammable material
Green	Sewers and drain lines
Blue	Drinking water
Purple	Reclaimed water, irrigation and slurry lines

All non-metallic conduits shall be watertight sealed using solid or split ring compression type duct plugs. Duct seal shall not be allowed. Couplings for HDPE conduits shall be compression type fittings that provide a watertight seal and full pullout resistance meeting ASTM D-3350.

LFNC shall be Underwriters Laboratories (UL) Listed (UL 1660 "*Liquid-Tight Flexible Nonmetallic Conduit*") category code DXOQ and used in accordance with NEC Article 356. Fittings for LFNC shall be mechanical connections manufactured to work specifically with LFNC. PVC cement shall not be used on LFNC. Flex shall be rated for 1000 Volts maximum.

When being installed for power applications, conduit and fittings shall be Underwriters Laboratories (UL) Listed for use as electrical conduit and carry the UL label. This UL label shall be marked as follows: (a) at 10 feet {3 m} length intervals for conduit; and, (b) stamped or molded on each fitting.

2. Exposed Non-Metallic Conduit.

Non-Metallic conduit installed exposed (above grade) shall be Rigid Polyvinyl Chloride Conduit (Type PVC) or Liquidtight Flexible Nonmetallic Conduit (Type LFNC). The exposed conduit shall be ultra-violet (UV) stable (sunlight resistant) per UL 651. Exposed conduit shall be Schedule 80 PVC and shall comply with the following conduit and fitting standards:

a. NEMA Standards Publication No. TC-2 "Electrical Polyvinyl Chloride (PVC) Conduit",

b. ASTM D4396, "*Standard Specifications for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Non-Pressure Applications*",

c. UL Standards No. 651 "*Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings*", and

d. NEMA TC-3 "*Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing*".

3. Underground Non-Metallic Conduit.

Non-Metallic Conduit installed underground (below grade) shall be High Density Polyethylene Conduit (Type HDPE). Underground HDPE conduit shall be Schedule 80 or SDR-11 (depending upon UL Listing requirements for non-fiber installations and as shown on the Plans). If rocky soil conditions are encountered during precision directional bore installations, SDR-9 HDPE may be required. Underground HDPE conduit shall comply with the following conduit and fitting standards:

a. NEMA Standards Publication No. TC-7, "Smooth-Wall Coilable Electrical Polyethylene Conduit",

b. ASTM D2239, "Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter",

c. ASTM D3035, "Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter",

d. ASTM F2160, "Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)",

e. ASTM D3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials" for a minimum cell classification of PE334480E/C,

f. ASTM F2176, "Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct", and

g. UL Standards No. 651A "Standard for Schedule 40 and 80 High Density Polyethylene Conduit".

(b) Metallic Conduit.

Metallic Conduit for ITS and related applications shall be Rigid Metal Conduit (Type RMC) of Galvanized Steel, thick wall, unless otherwise shown on the Plans. Metallic conduit shall be of the size shown on the Plans.

All metallic conduits shall conform to applicable Underwriters Laboratories (UL), NEC, ANSI, and National Electrical Contractors Association Standard (NECA) conduit and fitting standards.

Galvanized Steel RMC shall also conform to: UL Standards No. 6 "*Electrical Rigid Metallic Conduit - Steel*"; ANSI Standard Publication No. C80.1 "*American National Standard For Electrical Rigid Steel Conduit (ERSC)*" with the applicable zinc protection coating requirements; and, ANSI Standard Publication No. NECA 101 "*Standard for Installing Steel Conduits (Rigid, IMC, EMT)*". All conduits shall be homogeneous and shall have no visible cracks or holes. All metal accessories and fitting used with the conduit shall be compatible and shall also meet the galvanization requirements as specified within the Specification.

Conduit and fittings shall be Underwriters Laboratories (UL) Listed for use as electrical conduit and carry the UL label. This UL label shall be marked as follows: (a) at 10 feet {3 m} length intervals for conduit; and (b) stamped or molded on each fitting.

Use of RMC for electrical cable shall be installed in accordance with the NEC including bond grounds.

When installed on a bridge or similar surface, the couplings shall be designed and factory certified to handle expected expansion and contractions on a bridge application.

(c) Reinforced Thermosetting Resin Conduit (RTRC).

Reinforced Thermosetting Resin Conduit (RTRC) shall be of reinforced thermosetting resin material with outer diameter size as shown on the Plans meeting or exceeding the latest requirements of NEMA Standards Publication No. TC-14 "*Reinforced Thermosetting Resin Conduit (RTRC) and Fittings*" and UL 2515 "*Standard for Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings*". The conduit design shall be rated for above ground installations such as on a bridge structure. The outer conduit, joints, and any spare used internally, shall be all-dielectric. The conduit shall be ultra-violet (UV) stable (sunlight resistant) per UL 2515.

The joint assembly shall be tested in accordance with ASTM D2105 "*Standard Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube*". There shall be no water leakage through the joint when tested in accordance to UL Standard No. UL 2515 and CSA Standard C22.2 No. 2515, "*Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings*".

Conduit joints shall consist of an integral bell and spigot. The spigot end shall have a buttress type, male thread for easy installation. The belled end shall contain the mating female threads. The conduit joint shall be made in such a manner as to form a watertight seal.

The couplings shall be manufactured from a high impact thermoplastic material and shall be supplied with lead-ins to facilitate assembly.

The couplings shall be designed and factory certified to handle expected expansion and contractions on a bridge application.

Appropriate termination kits shall be provided by the conduit manufacturer for terminating the conduit in manholes and junction boxes.

(d) Pull Tape and Pulling Grip.

Pull Tape shall be manufactured of aramid yarn and rated at 2500 lbs minimum for the purpose of attaching to, and the pulling of fiber optic and electrical cables into a conduit system. Pull Tape shall have low elasticity to minimize surge-induced fluctuation in pull tape tension. Pull Tape shall not damage the conduit or cut the innerduct when under tension. Pull Tape shall be factory or field installed within conduit.

Pulling grips shall be used in accordance with the cable manufacturer's recommendations and Standard Operating Procedures. Pulling grips shall be factory or field installed along with a breakaway swivel; and shall be designed and rated for pulling fiber optic and electrical cables. Pulling grips shall provide effective coupling of pulling loads to the jacket, aramid yarn, and central member of the fiber optic cable per the cable manufacturer's requirements. The use of a swivel between the pull tape and pulling grip is required to prevent twist to the cable during the pulling operation and to limit exceeding the cable's maximum pulling tension.

(e) Friction Reduction Multiduct Sleeves.

Friction reduction multiduct sleeves are required for installing new fiber where indicated on the Plans and with cell quantity specified. When size and quantity are not indicated on the Plans, a minimum of 3-cells shall be provided. Size shall be based on conduit size. Each cell shall contain a Pull Tape, as specified within the Specifications. Friction reduction multiduct sleeves shall be manufactured of flexible polyester and nylon resin polymer textile material rated for the installed environment.

(f) Conductor.

All conductors shall be Type XHHW-2 stranded copper with 1000 Vac rated cross-linked polyethylene insulation, high heat, and moisture resistance conforming to ANSI/NEMA Standard No. WC 70 and ICEA Standard No. S-95-658, "*Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy*". Conductors shall be rated for conduit, direct burial, and sunlight resistance. Conductors shall be suitable for wet or dry conditions at temperatures not to exceed 194°F {90°C}.

Conductor size shall be such to exceed the amperage rating of the upstream breaker. Conductors shall be soft drawn annealed copper having a conductivity of at least 98 percent of pure copper. Wires shall be single conductor type for sizes smaller than 8 AWG. Wires shall be stranded for sizes 8 AWG and larger.

Insulation marking and color coding of conductors shall meet NEC standards.

(g) Locate Tone Wire.

Locate Tone Wire shall be a 12 AWG, solid copper wire with an orange jacket (a.k.a. trace wire or locate wire) and also meet the CONDUCTOR requirements as specified within this Specification. Locate Tone Wire shall be suited for direct burial and shall be continuous.

(h) Messenger and Guy Wire.

Messenger Wire (a.k.a. span wire) and Guy Wire (a.k.a. guy strand or down guy) for ITS and related applications shall be steel, seven (7) wire strand, Class A (double galvanized) and conform to the requirements of ASTM Standards Publication No. A 475, "*Standard Specifications for Zinc-Coated Wire Strand*". The cable shall be extra high-strength grade steel (EHS) with a minimum nominal diameter of 1/4 inch {6 mm} and a minimum breaking strength of 3,136 pounds {14.0 kN}.

All cable attachment hardware and fittings shall be new and stainless steel or non-corrosive material and shall be provided with tensile strength adequate for the application. Cable attachment hardware and fittings shall include, but not limited to: pole attachment hardware, cable ties and straps, lashing, extension arms, and pole extensions. Fiberglass insulators are to be provided in accordance with applicable NESC, NEC and local Utility standards.

Down guy shall have a guy marker (a.k.a. guy guard) with materials as specified in accordance with applicable NESC, NEMA and local Utility standards.

(i) Warning Tape.

Warning Tape shall consist of an underground/buried tape marking the locations of conduits containing fiber optic cables and/or electrical conductors as indicated on the Plans.

Warning tape shall be 3 inch {7.6 cm} wide, elastic PVC, tear resistant, corrosion resistant and durable to extreme weather conditions. The color of the tape shall be orange with "ALDOT FIBER OPTIC CABLE - CALL ALDOT [insert phone number to be provided by the TSMO Engineer]" printed every 3 feet {0.9 meter} in black letters, unless otherwise noted on the Plans.

The physical test methods along with typical properties and values are specified below:

TEST METHOD	TEST SPECIFICATION	TEST VALUE/UNITS
Standard Weight	ASTM-D2103	20 lbs/100 feet
Thickness-overall	ASTM-D2103	4 mil
3 in. Tensile Break-MD	ASTM-D882	35 lbs/ft
3 in. Tensile Strength-MD	ASTM-D882	4 kpsi
3 in. Tensile Break-TD	ASTM-D882	38 lbs/ft
3 in. Tensile Strength-TD	ASTM-882	5 kpsi
Elongation-MD	ASTM-882	530%
Elongation-TD	ASTM-882	660%
Tear Strength	ASTM-D2261	1.5 lbs/ft

893.11 Grounding.

All grounding conductors shall be either bare or insulated with green jacket in accordance with the NEC.

Grounding electrodes (rods) installed for ITS equipment installations shall be copper clad rods of minimum size 5/8 inch {16 mm} in diameter and 10 ft {3.0 m} long. All non-current carrying conductive material shall be bonded together and grounded to earth through the grounding electrode. Grounding electrodes shall be bonded by seven (7) strand copper wire or strap of the same cross-sectional area as a 6 AWG {4.25mm} wire. Grounding electrodes shall conform to the NEC requirements and be approved by the Underwriter's Laboratory (UL).

[See **Sub-Article 729.03(k)**, ***"Grounding, Lightning Protection, Insulation, and Circuit Continuity"*** for grounding system installation and testing requirements.]

893.12 Intelligent Transportation System (ITS) Cabinet.

(a) General.

All Intelligent Transportation System (ITS) Cabinets shall be of the same manufacturer per cabinet type, identical in size and shape, and of the same quality throughout the entire project. The ITS Cabinet shall be equipped internally as specified herein, and as required to suit the specific complement of equipment as shown on the Plans.

ITS Cabinets shall meet the following general requirements:

1. Material.

   ITS Cabinet housing shall be Aluminum alloy 5052-H32 at 0.125 inch thick (minimum) with a natural aluminum finish and continuously welded seams. ITS Cabinet housing shall be UL listed and meet below NEMA environmental rating requirements. ITS Cabinet exteriors shall be free of any sharp edges and spurs.

   For pole mounted applications, mount-side cabinet walls shall be designed to minimize deflection and cabinet movement. Some cabinet wall reinforcement may be necessary.

2. Cabinet Dimensions.

   ITS Cabinet dimensions are to be as indicated within each cabinet type and are approximate. A tolerance of -0% to +15% shall be allowed on each cabinet dimension indicated within their respective cabinet type table.

3. Environment.

ITS Cabinet shall meet or exceed NEMA Type 3R standard requirements and NEMA TS2 standard requirements for shock and vibration. ITS Cabinet shall withstand ambient operating temperatures from -40°F to 185°F {-40°C to 85°C}.

Louvered vents shall be installed on doors of the cabinet for ventilation. The bottom of the vents shall be within 3 to 6 inches from the bottom of the door. Vents shall be framed in to allow installation of air filter. The air filter shall be held in place securely against the door by a bottom bracket and a spring loaded upper clamp. No incoming air shall bypass the air filter. The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside housing.

An UL listed thermostatically controlled power vent and dual fans shall be provided. The thermostat shall activate the fans at 110°F {43°C} and de-activate the fans at 90°F {32°C} with an accuracy of ±5°F {±3°C}. Fans shall be rated at 100 cfm. Fans shall also be rated for three (3) year continuous service life and have ball bearings.

4. Cabinet Lighting.

ITS Cabinets shall utilize high efficiency Light-Emitting-Diode (LED) lighting fixtures. These light fixtures shall be 120 Vac or have a power supply conversion. Each light fixture shall have a lumen output of 600 to 1200 lumens at 4000°K to 5000°K (with a tolerance of ±300°K). The initial light fixture output level is to be set at 1,000 lumens minimum per door, unless otherwise directed by the Engineer. The light fixture shall be covered by a protective shield that prevents glare. These LED light fixtures shall be operated by a UL listed Class 2 power supply.

These LED lighting fixtures shall be provided and mounted inside the top portion of the ITS Cabinet for each door opening and under the cabinet drawer(s) so that it remains stationary when drawer is extended. LED light fixtures shall be mounted such that they can be easily removed and replaced without interference from other devices mounted in the ITS Cabinet.

All light fixtures shall be activated upon any door opening. Door switches along with necessary connections to the respective light fixture shall be provided. Door switches shall be made of durable materials and mounted in a manner that will withstand repeated use.

5. Doors.

Doors shall be weather-resistant and dust-tight with a closed cell gasket. Mating surface of the doors shall be covered with a silicone lubricant to prevent sticking. Top gasket shall be the width of the door, side gaskets shall begin below top gasket and bottom gasket shall be within the side gaskets. Doors shall include a retaining ring installed on the inside of the gasket for protection. Three-point latching system is required with each point controlled by the door handle for each door. The three-point latch points shall be at center, top, and bottom of each door. No plastic parts other than nylon rollers for top/bottom door secure is allowed. Door hinges, bolts, three-point latch system and pins shall be stainless steel or equivalent corrosion resistant material. When doors are open, a manufactured doorstop shall be included to hold the door open at a minimum of two positions, 90 degrees and 120 degrees.

ITS Cabinet doors shall be equipped with a brass or stainless-steel lock. Lock shall be ALDOT's standard Corbin #3 lock and key set. The Contractor shall coordinate with the Engineer to obtain cylinder code and key code. Two keys shall be provided for each lock. Locks will be permanently lubricated and be covered with a weatherproof tab. Door handle shall turn away from the lock to open the door. The keys shall be removable in the locked position only.

A plastic documentation pouch to store the ITS Cabinet and equipment documentation shall be provided. Pouch shall be side-opening, reseal-able, opaque, and of a heavy-duty plastic material. The pouch shall have metal or hard plastic reinforced holes for hanging from hooks included on the cabinet door. The pouch shall be of the size and strength to easily hold all wiring diagrams, equipment documentation and the maintenance logbook.

6. Rack Assembly.

ITS Cabinets shall be equipped with a 19-inch industrial rack frame assembly with a four-post design for mounting components in accordance with EIA/ECA-310 standard. Rack shall span the entire height of the ITS Cabinet. Depth of rack shall be adjustable for differing field conditions. Rack mounting panel(s) and mounting tray(s) shall be provided for installing the surface mount and standalone equipment, respectively. All cage nuts and screws required for mounting equipment to the rack shall also be provided. Additional cage nuts and screws, for mounting future equipment, shall be provided and placed in a plastic sealable bag attached to the rack.

7. Shelves.

All ITS Cabinets shall have a drawer that opens or is capable of sliding in and out for placing a notebook or laptop computer. Adjustable shelves shall be vented and provided in quantities as indicated in Dimension and General Requirements Table for each cabinet type. A hinged, aluminum shelf and integrated storage compartment shall be installed inside the front door for two-door cabinets. The shelf shall have a smooth, non-slip surface sufficient for use for a writing platform and laptop workspace. The shelf shall have rounded or insulated edges that do not have the potential to physically harm the user. The shelf and storage compartment shall have the ability to lock into place when folded for storage; locking, unlocking, and use of the components shall not require tools. Storage component shall be at least 1.5 inch {38 mm} deep and capable of holding letter-size (8.5 inch x 11 inch) documents/manuals, at minimum.

8. Electrical.

The following ITS Cabinet electrical requirements are minimum requirements and shall be adapted to field conditions as shown on the Plans. Each ITS device type (e.g. camera, VDS, DMS, etc.) shall have a separate dedicated circuit (i.e. branch circuit with circuit breaker).

Stranded copper wire shall be used with exception of earth ground conductor which shall be solid wire. Wiring shall be UL listed and 1000 Volts rated per NEC. Wiring shall be neatly arranged, labeled/tagged, and managed using wire management system and ties; wire to be appropriate lengths before assembly (i.e., no double backs to take up slack). Color of wires shall be in accordance with the NEC. Wiring within ITS Cabinet shall be continuous (i.e., no splices) landing on busbars, terminal strips, device clamp, or lug.

Minimum 12 AWG (American Wire Gage) wire for all conductors on 120 Vac circuits unless otherwise shown on the Plans. Terminal blocks shall be provided for incoming power with a rating greater than wire being terminated on the block and shielded for contact protection. Grounding bus shall be provided for both earth ground and AC neutral/common (each isolated from the other). Electrical terminations shall be shielded (i.e., touch safe) to protect from accidental shock.

The ITS Cabinet shall contain minimum two (2) 15-amp rated convenience receptacles (NEMA Type 5-15R) with GFCI protection and be on an isolated circuit protected by a 20-amp breaker. These GFCI protected receptacles are to be designated for “Technician Service Use Only”.

Mounted power distribution unit(s) or power strip outlet(s) shall be provided near the top of each ITS Cabinet for providing power to the ITS equipment. The power strip shall incorporate eight (8) NEMA Type 5-15R receptacles and be on an isolated circuit protected by a 20-amp breaker unless otherwise shown on the Plans. The power strip receptacle shall face the back of the cabinet and shall be recessed within the cabinet rack to provide a minimum spacing of 3 inches {76 mm} between the outlet’s face and the cabinet door when the door is closed.

Only circuit breakers that are Underwriters Laboratories (UL) approved and plainly marked with trip and frame sizes and ampere rating shall be used. All circuit breakers shall be quick-make, quick-break on either automatic or manual operations. Contacts shall be silver alloy and enclosed in an arc-quenching chamber. Circuit breakers shall be standard panel-mount or channel-mount. Overload tripping shall not be influenced by an ambient air temperature range from -0.5°F to 122°F {-18°C to 50°C}. Minimum interrupting capacity shall be 5,000 amperes RMS.

Busbars shall be fabricated from a copper alloy material compatible with copper wire. Busbars shall be used for termination of ground or neutral conductors. The earth ground busbar shall have at least two positions capable of terminating a 6 AWG conductor. With multiple busbars, each busbar shall be interconnected via a 10 AWG conductor.

Terminal blocks and strips with voltage and current ratings greater than the voltage and current ratings of the wires that are terminated on the blocks or strips shall be used. The terminal block for the 120 Vac cabinet service entrance (SE) shall be a tubular clamp compression device that is fully insulated (Marathon 1103P or approved equivalent). Terminal blocks for 120 Vac power wiring (TB1, TB2) shall be on dual-screen barrier type terminal blocks with 9/16 in {14.3 mm} spacing using nickel-plated brass 8-32 Philips slot screw and fork terminal lugs (Cinch 142 or approved equivalent). TB1 and TB2 shall have at least eight (8) terminal positions. Compression-type and tubular clamp terminal blocks shall be used only for service entrance block. Spade lug terminals shall not be used for any terminal block.

A 30-amp generator male receptacle, in a NEMA Type 3R rated enclosure shall be provided external to cabinet for quick generator connection.

9. Surge Protection.

Surge-Protective Device(s) are required in accordance with Item 729.03(q)7, "*Installation of Surge-Protective Devices*" and shall be as specified in Sub-Article 893.17(i), "*Surge Protection*".

10. Foundation (Mounting Pad).

Where the ITS Cabinet is pad mounted, the mounting pad foundation shall be concrete and as shown on the Plans.

The concrete mix used for mounting pads shall comply with the requirements of **Section 501** for Class A concrete and **Section 620**, unless otherwise shown on the Plans. Mounting pad shall be formed separately from any ITS concrete pole or structure foundations; and, the concrete shall include wire mesh.

Reinforcing steel shall meet the requirements of **Section 502** and as shown on the Plans.

11. Concrete Pad (Service Platform).

Where the ITS Cabinet is pole or structure mounted, the service platform pad shall be concrete and as shown on the Plans.

The concrete mix used for this service platform shall comply with the requirements of **Section 501** for Class A concrete and **Section 620**, unless otherwise shown on the Plans. Concrete pad shall be formed separately from any ITS concrete pole or structure foundations; and, the concrete shall include wire mesh.

Reinforcing steel shall meet the requirements of **Section 502** and as shown on the Plans.

12. Uninterruptible Power Supply.

The Uninterruptible Power Supply (UPS) unit for the ITS Cabinet shall be rack mounted and as shown on the Plans. The UPS unit shall also meet the minimum requirements of **Sub-Article 893.17(j) "Uninterruptible Power Supply (UPS)"**.

The UPS unit shall include all battery packs, power cables, mounting brackets and all appurtenances necessary for a complete operational backup power system; adequately sized to support the ITS cabinet equipment and operations.

The UPS unit shall typically support the ITS cabinet equipment as follows (unless otherwise shown on the Plans): Managed Ethernet Switch and ITS Cabinet equipment (e.g. cabinet lighting, fans, ITS equipment receptacles, and convenience receptacle).

(b) Type 337.

ITS Cabinet Type 337 shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	35.25 in.
Width	20.50 in.
Depth	18.125 in.
Mounting	POLE/PEDESTAL
Number of Doors	2
Door Location(s)	FRONT/REAR
Number of Adjustable Shelves	1
Rack Assembly	Yes
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (24 each front door only)
Air Filter Size	12 in. x 16 in.
GFCI Receptacles	1-Duplex
Equipment Receptacles	1-Duplex
Breakers	DIN rail mounted breakers. One 30-amp main breaker; one 20-amp breaker for cabinet lights, fans, and convenience receptacle; one 20-amp breaker for device receptacle; and additional 20-amp breakers required for any and each additional convenience receptacle as required on the Plans

(c) Type 332S.

ITS Cabinet Type 332S shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	66.75 in.
Width	24.25 in.
Depth	30.25 in.
Mounting	BASE
Number of Doors	2
Door Location(s)	FRONT/REAR
Number of Adjustable Shelves	2
Rack Assembly	Yes
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (24 each per door)
Air Filter Size	12 in. x 16 in.
GFCI Receptacles	One Duplex
Equipment Receptacles	One Duplex
Breakers	DIN rail mounted breakers. One 30-amp main breaker; one 20-amp breaker for cabinet lights, fans, and convenience receptacle; one 20-amp breaker for device receptacle; and additional 20-amp breakers required for any and each additional convenience receptacle as required on the Plans

(d) Type 332D (Quad).

ITS Cabinet Type 332D (QUAD) shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	66.00 in.
Width	44.25 in.
Depth	28.50 in.
Mounting	BASE
Number of Doors	4
Door Location(s)	(2 each) FRONT, (2 each) REAR
Number of Adjustable Shelves	4
Rack Assembly	Yes, Qty. (2)
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (24 each per door)
Air Filter Size	12 in. x 16in.
GFCI Receptacles	One Quadruplex per side
Equipment Receptacles	One Quadruplex per side
Breakers	Panelboard shall be 100-amp rated with 30-amp main breaker and 6 bolt-on type breakers unless specified otherwise on the Plans; one 20-amp breaker for cabinet lights, fans, and convenience receptacle; one 20-amp breaker for device receptacle; and additional 20-amp breakers required for any and each additional convenience receptacle as required on the Plans

(e) Type 336S.

ITS Cabinet Type 336S shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	46.25 in.
Width	24.25 in.
Depth	22.25 in.
Mounting	BASE/POLE
Number of Doors	2
Door Location(s)	FRONT/REAR
Number of Adjustable Shelves	2
Rack Assembly	Yes
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (12 each per door)
Air Filter Size	12 in. x 16 in.
GFCI Receptacles	One Duplex
Equipment Receptacles	One Duplex
Breakers	DIN rail mounted breakers. One 30-amp main breaker; one 20-amp breaker for cabinet lights, fans, and convenience receptacle; one 20-amp breaker for device receptacle; and additional 20-amp breakers required for any and each additional convenience receptacle as required on the Plans

(f) Type 334.

ITS Cabinet Type 334 shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	67 in.
Width	24.3 in.
Depth	30 in.
Mounting	BASE/POLE
Number of Doors	2
Door Location(s)	FRONT/REAR
Number of Adjustable Shelves	2 (minimum)
Rack Assembly	Yes
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (12 each per door)
Air Filter Size	12 in. x 16 in.
Technician Receptacles	One Duplex (non-GFCI)
Equipment Receptacles	One Duplex and One Quadruplex
Breakers	DIN rail mounted breakers. One 30-amp main breaker; one 20-amp breaker for cabinet lighting, fans, and (non-GFCI) convenience receptacle; one 15-amp breaker for device receptacle, powered from UPS if available; and additional 15-amp breakers required for any and each additional convenience receptacle as required on the Plans.

Relays	When an Uninterruptible Power Supply (UPS) is present, both equipment receptacles shall be powered through the UPS. The Duplex receptacle shall be powered through a relay that is switched on/off by dry contacts on the UPS.
Cabinet UPS Status LEDs	When a UPS is present, cabinet LEDs shall be provided which indicate the UPS status. These cabinet LEDs shall be installed on the door with the best visibility from the road unless otherwise specified. These cabinet LEDs shall be connected through relays such that a green LED is ON under normal circumstances and an amber LED is ON when the relay is activated via dry contact from the UPS.
Fiber Distribution Unit	Secondary Fiber Distribution Unit (SFDU) shall be a slidable 1U rack-mounted unit for terminating the optical fiber drop cable. SFDU shall be a 2-connector panel design. Cable management shall be accessible from the top of the SFDU when the drawer is in an open position. There shall be sufficient cable slack to allow the drawer to be fully functional. This SFDU shall also meet all other requirements as specified in **Article 893.03** and as shown on the Plans.

(g) Hub (Quad).

ITS Cabinet, Hub (Quad) shall also meet the following requirements:

DESCRIPTION	SPECIFICATION
Height	72 in.
Width	60 in.
Depth	48 in.
Mounting	BASE
Number of Doors	4
Door Location(s)	(2 each) FRONT, (2 each) REAR
Number of Adjustable Shelves	4 (minimum)
Rack Assembly	Yes, Qty. (4)
Louvered Vent Size (length x vent depth)	3.00 in. x 0.25 in. (24 each per door)
Air Filter Size	12 in. x 16 in.
Technician Receptacles	One Duplex (non-GFCI) per side
Equipment Receptacles	One Duplex and One Quadruplex per side
Breakers	DIN rail mounted breakers. One 30-amp main breaker; one 20-amp breaker for cabinet lighting, fans, and (non-GFCI) convenience receptacle; one 15-amp breaker for device receptacle, powered from UPS if available; and additional 15-amp breakers required for any and each additional convenience receptacle as required on the Plans.

Relays	When an Uninterruptible Power Supply (UPS) is present, both equipment receptacles shall be powered through the UPS. The Duplex receptacle shall be powered through a relay that is switched on/off by dry contacts on the UPS.
Cabinet UPS Status LEDs	When a UPS is present, cabinet LEDs shall be provided which indicate the UPS status. These cabinet LEDs shall be installed on the door with the best visibility from the road unless otherwise specified. These cabinet LEDs shall be connected through relays such that a green LED is ON under normal circumstances and an amber LED is ON when the relay is activated via dry contact from the UPS.
Fiber Distribution Unit	Primary Fiber Distribution Unit (SFDU) shall be used for terminating the optical fiber drop cable. This PFDU shall also meet all other requirements as specified in **Article 893.03** and as shown on the Plans.

893.13 Electrical Power Service and Transformer.

Electrical Power Service assembly shall consist of equipment to provide a pole attached raceway and disconnect switch for use with power cable routed from the service entrance to the ITS Cabinet. The electrical power service assembly shall include (at a minimum): service pole, weatherhead, conduit and fittings, electrical cable/conductors (from utility power source to service pole), riser, disconnect switch(es) with enclosure, grounding, and attachment clamps. Lateral/horizontal conductors, after the service disconnect/meter base and to the ITS cabinets/equipment, are not part of the Electrical Power Service assembly.

Electrical power service shall be in accordance with these Specifications, Plans, NEC requirements, and local utility codes. Electrical power shall be provided by a Utility Company transformer that does not provide power to any other equipment or clients unless otherwise noted on Plans or approved by the Engineer.

Electrical service power runs will typically be a 120/240 Vac system unless otherwise supplied by the Utility Company and/or shown on the Plans. For 480 volt systems or greater, a meter disconnect switch shall be installed on the supply side of the meter and meter base in accordance with NEC Article 230 (especially Sub-Article 230.82) and as directed by the Utility Company.

Depending upon the electrical service provided, step-up and step-down transformers may be required (e.g. for DMS or long-runs) as shown on the Plans. Typically, these transformers shall be provided by the contractor and installed at the service pole location with another corresponding transformer at the ITS Cabinet/equipment site as indicated on the Plans.

Materials shall be tested and approved by a nationally recognized testing laboratory and shall meet the following requirements:

(a) Service Pole (Wood Pole).

Service Pole shall be southern yellow pine treated in accordance with the latest American Wood-Preserver's Association (AWPA) standards and shall conform with requirements given in **Section 833**.

Unless otherwise shown on the Plans, service pole used for service lateral drop shall be a 35 foot {10.7 m} Class 3 wood pole and shall conform to the requirements of ANSI Standards Publication No. O5.1, *"American National Standard for Wood Utility Products – Wood Poles: Specifications and Dimensions"* as published by American Wood Protection Association (AWPA), Birmingham, Alabama.

The poles shall not have more than 180 degrees of twist in grain over the full length and the sweep shall be no more than 4 inches {100 mm}.

(b) Electrical Cable and Conductors.

Phase or current carrying conductors shall be of the type RHH, RHW, USE, or XHHW. Size shall be of the size shown on the Plans and in accordance with the NEC.

Conductors shall be stranded annealed copper with not less than 98 percent conductivity and shall be insulated for 1000 Volts or more with rubber insulation and a neoprene jacket, or with cross-linked polyethylene insulation.

Electrical Power Service Cable and Conductors shall also meet the requirements of **Sub-Article 893.10(f), *"Conductor"***.

(c) Conduit.

Conduit shall conform to the requirements specified in these Specifications and as shown on the Plans. Only UL Listed conduit shall be used for electrical power service installations.

(d) Weatherhead.

Weatherhead shall be made of a copper-free aluminum alloy or galvanized ferrous material.

(e) Attachment Hardware.

Attachment hardware shall meet the requirements of this Section and as shown on the details in the Special and Standard Highway Drawings, unless otherwise shown on the Plans.

(f) Guy Wire.

Guy Wire (a.k.a. down guy) shall meet the requirements of this Section and as shown on the details in the Special and Standard Highway Drawings, unless otherwise shown on the Plans.

(g) Meter Base and Meter Disconnect.

When a meter base is required, the meter base shall be a meter base approved by the local Utility Company. When a meter disconnect is required, the meter disconnect switch shall be a meter disconnect meeting below service disconnect requirements (without key option unless otherwise specified by the Utility Company), NEMA rated enclosure for intended outdoor use, rated for the service supply voltage, and approved by the local Utility Company.

(h) Service Disconnect.

1. Enclosure Cabinet:

   The Enclosure Cabinet shall conform to NEMA standards, made of galvanized steel, aluminum, stainless steel or other material approved by the Engineer. The enclosure shall have a hinged door with a padlock. Padlock No. 3210 keyed for a No. 3 key shall be provided. One key for the enclosure cabinet shall be hung within the corresponding ITS Cabinet.

2. Circuit Breaker:

   A manually re-settable circuit breaker shall be installed, which has a current rating of the circuit to which electrical power is provided.

3. Transient Protective Device:

   A surge lightning arrestor rated for a maximum permissible line to ground voltage of 175 Vac shall be installed; and meeting the requirements of NEMA standards for surge arrestors and also as specified in **Sub-Article 893.17(i), "*Surge Protection*"**.

(i) Grounding.

Grounding and grounding electrodes shall be as specified in this Specification unless otherwise shown on the Plans.

(j) Transformer (Step-Up/Step-Down).

If required, Step-Up/Step-Down Transformer(s) shall be provided for each Dynamic Message Sign (DMS) installation site where power is not available in close proximity to the DMS equipment and voltage drops will require a higher distribution voltage than the Utility Company supplied power (typically 120/240 volt service). If required, a step-down transformer may also be provided for each ITS Cabinet installation site as indicated on the Plans.

The step-up/step-down transformer shall be a dry type transformer as recommended by the local Utility Company and approved by the Engineer. The transformer KVA size and primary/ secondary voltages shall be as indicated on the Plans and approved by the Engineer. The transformer shall be mounted in a NEMA 3R enclosure and have all the appurtenances necessary for a complete electrical power service installation and to accommodate the required ITS equipment and ITS Cabinet. Disconnecting means (disconnect switch) shall be required for all transformers in accordance with NEC Article 450.14 and shall be located in close proximity to each transformer as allowed by NEC.

893.14 Intelligent Transportation System (ITS) Pole.

(a) General.

Intelligent Transportation System (ITS) Poles shall primarily be a concrete pole for ITS applications (e.g. cameras with or without other ITS devices). Metal poles with either auger base or concrete foundations are typically used for vehicle detection equipment (i.e. radar or magnetometers) only. ITS

Pole shall be in accordance with the Plans and these Specifications. ITS Poles shall also conform to the requirements of **Section 718** and **Section 891**.

Unless otherwise shown on the Plans, the ITS Pole shall have the following minimum accessories:

- a 4 inch x 8 inch {10 cm x 20 cm} conduit entrance opening, centered 18 inches {46 cm} below grade; and,
- a 4 inch x 8 inch {10 cm x 20 cm} reinforced hand hole frame with cover, located 24 inches {61 cm} above grade and centered on same side as the below grade conduit entrance.

In addition to the requirements of **Section 718**, deflection shall not exceed 1 inch {25 mm} in 30 mph {45 km/h} wind for poles 70 ft. {21.3 m} or less.

(b) Concrete Foundations.

Concrete Foundations for metal ITS Poles shall be in accordance with the Plans and these Specifications. Concrete Foundations shall also conform to the requirements of **Section 718** and **Section 891**.

(c) Auger Base Foundations.

Auger Base Foundations (screw-in helix type) shall be ***for vehicle detection installations only (i.e. radar and magnetometer)*** as shown on the Plans and in accordance with these Specifications. Auger Base Foundations shall also conform to the requirements of **Section 718** and **Section 891**.

Materials used for auger base foundations must meet the requirements of ICC Evaluation Service (ICC-ES) AC358, "*Acceptance Criteria for Helical Foundation Systems and Devices*" and Earth Contact Products (ECP) "*Utility Industry Anchor Design and Maintenance Manual*", Second Edition (2013).

The design of the auger base foundations (screw-in helix type) must be done by a licensed design professional specialized in the engineering and design of auger base foundations and helical piles. The designer shall be a licensed Professional Engineer in the State of Alabama and must have designed at least five projects utilizing helical piles. Supporting documentation for license and minimum design experience shall be provided upon request of the Engineer. Design calculations shall be in accordance with the requirements of **Section 718**. The selected auger base size shall be a standard manufacturer size based upon the Professional Engineer's pole and foundation calculations at each ITS pole location. Pre-drilled bolt patterns for the auger base foundation base plate and corresponding metal pole base plate shall match. No drilling or modifications to the base plates will be allowed in the field.

All welds shall be made in accordance with the American Welding Society Standard ANSI/AWS D1.1, "*Structural Welding Code - Steel*", latest edition. Welders shall be certified in accordance with the ANSI/AWS Code. The completed foundation shall be hot dipped galvanized for underground use.

893.15 Hub Building.

(a) General.

Hub Building shall consist of a reinforced concrete or concrete composite building with concrete foundation, generator, automatic transfer switch and an uninterruptible power supply. This Hub Building is to be manufactured for the explicit use of housing the electronic communication equipment, power supplies, fiber optic equipment and cabling, measuring devices, and other related components necessary for the proper operation of an ITS deployment.

(b) Hub Building and Equipment.

Hub Building shall be reinforced concrete or concrete composite precast design in a size as shown on the Plans. Hub building shall be produced in its entirety at the manufacturer's facility and delivered and set-up complete at the Engineer's designated location as shown on the Plans. Each building shall have minimum 6.5 inch {165 mm} thick walls and minimum 4 inch {102 mm} thick ceiling and floor. The wall thickness should consist of, at a minimum, 4 inch {102 mm} concrete plus insulation and paneling for a total thickness of 6.5 inches {165 mm}. Hub Building shall be capable of withstanding minimum loads in accordance with local wind loads and environmental conditions where building is to be installed. Design must also consider stresses induced during handling, shipping and installation in order to avoid product cracking or other handling damage. Hub building shall maintain an interior building height of 9 ft. 6 in. {2.9 m} minimum from finished floor to finished ceiling.

Hub Building's exterior shall have a bullet-resistant surface in accordance with UL 752 "*Standard for Bullet-Resisting Equipment*". Hub building's exterior shall also be a concrete aggregate finish where color is earth tone to blend with its surroundings, unless otherwise shown on the Plans. Alternative exterior finishes or colors must have prior Engineer approval before hub building is manufactured.

Hub Building's interior floor covering shall be an industrial-grade vinyl flooring fastened to the building's floor with waterproof glue.

Hub Building shall be supplied with vapor shield in walls and ceiling to prevent moisture penetration. Hub building shall also have an air gap between the building floor and the slab, or alternatively, construct the slab with a vapor barrier as recommended by the hub building manufacturer to prevent moisture penetration. Hub Building shall be insulated as follows: ceiling/roof with a minimum Type R-21 insulation factor; walls with a minimum Type R-14 insulation factor; and floor with a minimum Type R-11 insulation factor. Roof is to be constructed with a 1/8 inch per foot minimum pitch for drainage.

Hub Building shall be furnished complete with the following installed equipment, at a minimum:

1. Electrical and Rack Equipment:
   a. 200-Amp load center;
   b. (11 each) 20-amp 120 volt duplex receptacle [divided into a minimum of 4 circuit groups];
   c. copper grounding electrode system;
   d. (55 feet) 2 AWG copper ground wire Halo ground, green insulation;
   e. (24 each) Clic Strap or equivalent for 2 AWG ground Halo support or equivalent;
   f. (6 each) compression fitting for 2 AWG by two wire;
   g. (30 feet) 6 AWG copper ground wire, green insulation;
   h. (9 each) compression fitting for 6 AWG by two wire;
   i. (25 each) two hole crimp fitting for 6 AWG wire;
   j. (11 each) one hole ring terminal for 6 AWG wire;
   k. two hole copper lug for 2 AWG wire;
   l. (26 each) ceramic insulators for 2 AWG wire;
   m. 12 inch by 12 inch NEMA enclosure;
   n. 50 point reliable terminal strip;
   o. 65.5 feet of 61 inch cable rack central steel painted;
   p. (2) pieces 2 inch by 3 feet mounting channel;
   q. (16 each) cable rack wall mounting bracket;
   r. (4 each) plastics end caps;
2. Surge Protection:

MOV type with peak surge rating of 50,000 amps (8x20 uS) with a response time of <5 nanoseconds with a maximum clamp voltage of 420 volts at 1 mA and 700 amps at 700 volts;

3. Door and Entrance:

   a. approximate 3 ft by 7 ft {0.91 m by 2.1 m} by 1-3/4 in {45 mm} thick armor shield bullet resistant door with standard door drip cap;
   b. door is to be a minimum of 18 gauge galvanized steel with stainless steel ball bearing hinges;
   c. door to be primed, painted brown and cast into the wall panel;
   d. 56 inch wide by 24 inch deep {142 cm wide by 61 cm deep} door awning;
   e. best Mortise lockset with deadbolt;
   f. hydraulic door closure with thumb turn;
   g. weather-stripping;
   h. magnetic door contact;
   i. concrete or concrete composite steps with hand rail installed so the distance from the grade to the hub building floor does not exceed 8 inches {20 cm};
4. Lighting**:**

   a. *Exterior*: outdoor security LED floodlight with adjustable dual-heads (minimum), switched photocell, motion sensor (minimum 180° up to 50 feet, selectable duration), weatherproof NEMA 3R rated, and UL Listed; die-cast aluminum housing with powder coated paint finish; outside/exterior mount by door for security of entry area; and Warm White (3000K), 2000 lumens (minimum) LED lights unless otherwise indicated on the Plans;

   b. *Interior*: (6 each) 4 feet LED light fixture with two 50-Watt equivalent, 5000 lumens, 5000K color temperature, LED tubes along with diffuser lens for inside hub building unless otherwise indicated on the Plans;

   c. (2 each) 20-amp 120 volt light switch;
5. Heating/Air-Conditioning:

   a. (2 each; one for operation and one for backup) 24,000 BTU 50-amp @ 240 Volt HVAC with 8kW Heat and 30-amp Dehumidifier;

b. high/low temperature thermostat (for dual backup system);
c. HVAC thermostat (for dual backup system);
d. Humidistat (for dual backup system);

6. Fire Protection:
a. (2 each) 120 volt smoke detector with remote contact;
b. fire extinguisher, 110 lbs. ABC dry chemical, wall mounted (rated for electrical equipment);

7. Fence:
a. 10 feet high fence chain link encircling the hub with the fence set off from the building by minimum of 10 feet, with 18 in. diameter of razor wire strung around the top of the fence and gate [*this item shall be paid separately and as shown on the Plans*];
b. with (2 each) 6 feet drive gates [this item shall be paid separately and as shown on the Plans];
c. and a lock with two (2) sets of keys shall be provided at each gate. The locks shall be approved by the Engineer.
d. Fencing materials shall also meet the requirements of **Section 871** and as shown on the Plans.

[*PLEASE NOTE*: Quantities and items listed are minimum. Latest codes and building manufacturer may require additional quantities and items not listed above nor shown on the Plans.]

Hub Building and equipment racks shall also be furnished with a Halo Grounding Ring System which meets the applicable grounding requirements of ANSI/TIA-607-B "*Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*".

(c) Hub Building Foundation.

Hub Building Foundation shall be reinforced concrete as shown on the Plans.

The concrete mix used for the foundation shall comply with the requirements of **Section 501** for Class A concrete, unless otherwise shown on the Plans.

Reinforcing steel shall meet the requirements of **Section 502** and as shown on the Plans.

(d) Generator.

The Generator shall be fully compatible and interoperable with the Automatic Transfer Switch. The Generator's electrical characteristics (i.e. size, power inputs and load outputs, line conditioning, etc.) shall be as shown on the Plans. The Generator shall include the manufacturer's recommended concrete pad installed as shown on the Plans. The Generator shall include the gas utility service and connections in accordance with the gas Utility Company requirements, these Specifications (see **Sub-Article 729.03(p)** and **Article 893.16, *"Gas Utility Service"***), and as shown on the Plans.

(e) Automatic Transfer Switch.

The Automatic Transfer Switch shall be fully compatible and interoperable with the Generator. The Automatic Transfer Switch shall be in accordance with the NEC and Utility Company requirements and as shown on the Plans.

(f) Uninterruptible Power Supply.

The Uninterruptible Power Supply (UPS) units for the Hub Building shall be two (2) each, rack mounted (or as indicated on the Plans), and as shown on the Plans. The UPS units shall also meet the minimum requirements of **Sub-Article 893.17(j) "Uninterruptible Power Supply (UPS)"**.

The UPS units shall include all battery packs, power cables, mounting brackets and all appurtenances necessary for a complete operational backup power system; adequately sized to support the hub building equipment and operations.

The UPS units shall typically support the hub building equipment as follows (unless otherwise shown on the Plans): each UPS will be plugged directly into one dedicated NEMA L5-30 two-pole twist-lock plug, while one UPS will feed the power supply in the Managed Ethernet Switch (MES) and the other UPS will feed the redundant power supply side of this Managed Ethernet Switch. The remaining hub building equipment will be distributed evenly between these two UPS units, allowing both a circuit and/or UPS failure on one side while still allowing the Hub Building's Managed Ethernet Switch to continue working.

893.16 Gas Utility Service.

Gas Utility Service shall consist of equipment to provide a natural gas feed to the Hub Building Generator, unless otherwise indicated on the Plans. The gas utility service components shall include (at a minimum): a gas meter, gas line pressure regulator (if required), piping and fittings, along with any

appurtenances as required by the local gas Utility Company. All gas utility service components shall meet applicable material requirements of the American Gas Association (AGA), National Fuel Gas Code (NFGC), and the local gas Utility Company.

Gas Utility Service shall also meet the requirements of **Section 646** and **Section 861**.

893.17 Miscellaneous Infrastructure.

(a) Fusion Splicing.

All fiber optic cable splices shall be Fusion Splices. Mechanical splices are prohibited.

Maximum core alignment shall be verified prior to splicing and splice estimated loss measured after the fusion process by the use of local injection and detection (LID) devices and/or profile alignment algorithms. Not only shall the fusion splicer automatically align fibers, determine cleave quality and fuse the fibers, but they shall also provide the operator with reference estimated splice loss measurements.

Splice loss attenuation for fusion splicing for single-mode shall be 0.15 dB maximum.

1. Fusion Heat Shrink Sleeves.

   The Contractor shall use heat-shrink sleeves to protect the fusion splice of 250 µm coated fibers while offering individual access to each fusion splice. The heat-shrink sleeves shall be compatible with the splice trays (whether existing or provided on this project). The heat-shrink sleeve protector parameters shall meet the following:

   a. Dimensions (length) Single-Fiber Sleeve: 2.36 inches {60 mm} lengths;

   b. Bare Fiber Length not more than 1.18 inches {30 mm} or 2 inches {51 mm} (based on length of sleeve)

   c. Shrink Temperature Single-Fiber Sleeve: 248°F {120°C};

   d. Heating Time Single-Fiber Sleeve as recommended by the manufacturers.

2. Fusion Splice Protection.

   When splicing all fiber optic cables outdoors, the Contractor shall provide and utilize an industry acceptable, lighted, and clean fiber optic splicing trailer/lab or comparable facility. Prior to the Contractor performing any fiber optic work, the Engineer shall approve the fiber optic splicing trailer/lab or comparable facility to be used on this project.

3. Cleave Tool.

   Cleave tool's minimum end angle average shall be < 0.7 degree angle with none of the 150 cleaves sampled exceeding a 1.5 degree angle.

   If requested by the Engineer, the Contractor shall submit the part number and manufacturer of the cleave tool along with an "*end angle*" distribution chart which demonstrates the actual 150 cut end angles.

(b) Splice Closure.

The following material specifications covers Splice Closure equipment requirements for housing and managing outside plant fusion splices, whether installed in underground or aerial applications.

1. General.

   For outside plant installations, the Contractor shall provide inline or dome-type sealed splice closures that meet the requirements herein for use in the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes. Splice closures shall pass the factory test procedures per accepted industry standards: i.e. Telcordia/Bellsouth GR-771-CORE, ASTM G-26 (UV resistance), ASTM G-21 (fungus resistance), water immersion, freeze/thaw, salt fog, acidified saltwater, chemical immersion, compression, impact/drop, torsion/bending, current surge, bond clamp retention, and cable pullout among others. If requested by the Engineer, the Contractor shall submit copies of these manufacturer's factory test results.

   The splice closure housing shall be a thermoplastic body design and suitable for butt, inline and branch splices. The splice closure shall have corrosion resistant aluminum or stainless-steel hardware. Splice closure shall be resistant to solvents, stress cracking, and creep. The housing materials shall also be resistant to chemicals and other materials to which they might be exposed in normal applications.

   The installation of the splice closure shall not require specialized tools or equipment, other than those normally carried by installation and maintenance crews.

   Splice closures shall be totally re-enterable without damage to fiber optics, their jackets and closure seal(s). The splice closure end cap shall be capable of accepting additional cables without removal of the sheath retention or strength member clamping hardware on previously installed cables

or disturbing existing splices. The optical fiber splice closure shall provide a clamping mechanism to prevent piston movement of the central member or strength members and to prevent cable sheath slip or pullout.

The Contractor shall use splice closures that seal around cables with mechanical processes. Splice closure shall provide adequate strain relief to meet fiber cable manufacturer recommendations. The splice closure shall have flexible thermoplastic rubber end seals with pre-template cable ports. The splice closure shall have a single clamping mechanism for accessing splice trays and cable management. A single rubber gasket shall be used to seal the closure using the single clamping mechanism. The rubber gasket shall be continuous without any holes and shall not require replacement for re-entry.

Aerial splice closure shall be of an inline housing design, unless otherwise indicated on the Plans or approved by the Engineer. Aerial splice closure shall be designed to eliminate the need for drip collars and sealing collars.

2. Mounting Hardware.

The Contractor shall supply splice closures with manufacturer recommended mounting hardware, whether installed aerially or underground. This mounting hardware shall be non-corrosive metallic material (hot dipped galvanized steel, stainless steel or aluminum) unless otherwise specified by the splice closure manufacturer and approved by the Engineer.

The splice closure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and the armored cable sheath. The cable bonding hardware shall be able to accommodate a copper grounding conductor equal to or larger than 6 AWG.

3. Optical Fiber Organizer.

Fiber organization shall be handled within the splice closure in such a way to protect and support the fiber optic cable and splices in a secure environment. The organizer shall store fiber splices, splice trays, slack buffer tubes and readily accept these cable configurations (trunk/butt, in-line and branch (up to four drop cables)). The organizer should be of a stackable splice tray design where tray assembly swings out to allow individual tray access without disassembly of trays above and below. The splice closure organizer shall accept a minimum of four splice trays, one-piece cable strapping system, bonding and grounding hardware as required for the project.

4. Splice Tray.

Fiber splices shall be housed in Splice Trays inside the splice closure. The proper splice tray shall be selected based on the type of protection required by the single-mode fiber splice, quantity of splices, and manufacturer of closure. Splice trays shall provide adequate strain relief tie down points for the buffer tubes (using channel snaps) and fiber as well as provide a snug fit for heat shrink sleeves. Splice trays shall be of stackable design. Splice trays shall provide adequate area for bare fiber slack storage and management. Spliced fiber shall not be subjected to a bend radius smaller than 1.2 inches {30mm}. Buffer tubes shall not be subjected to a bend radius smaller than 1.5 inches {38 mm}.

The Contractor shall supply splice trays compatible and of the same manufacturer as the supplied splice closure.

When identified on the Plans that new splice trays are required for existing closure, the Contractor shall provide splice trays that shall work within the existing closure using the same methodology, connections, firmness, and supports as existing splice trays.

(c) Hangers.

Conduits required on structures shall be installed using a conduit hanger for conduit with spacing and support as detailed on the Plans.

The conduit hangers shall utilize anchors, brackets, or clamps to provide attachment to a bridge structure. Mechanical anchors for connection required when attachment to bridge will be in tension. Otherwise, epoxy type anchors may be allowed. Drilling into bridge steel structure or concrete girders is not allowed except with written approval by the Engineer. Bridge attachment shall be submitted to committee for review and approval prior to installation.

Conduit hanger system used shall be recommended by the conduit manufacturer for the application.

The conduit hanger shall be capable of supporting a load equal to the weights of the conduits, cables, the weight of the hanger itself, plus 200 pounds.

Metal brackets, supports, and hardware components of the conduit hangers shall be manufactured galvanized steel.

(d) Riser Assembly.

The Contractor shall furnish and install Riser Assembly in accordance with the Plans. The Riser Assembly shall consist of a metallic riser, mounting brackets, straps, supports, any accessories, and required hardware. All attachment hardware shall be made of galvanized steel.

For electrical service installations, the riser shall be 2 inch {53 mm} galvanized steel Rigid Metal Conduit (RMC), unless otherwise shown on the Plans.

For fiber optic installations, the riser shall be a minimum 2 inch {53 mm} galvanized rigid steel U-Guard with backplate, unless otherwise shown on the Plans.

(e) Communication Box (CommBox).

1. Materials and Load Requirements.

Communication Box (CommBox) shall have the following properties: high strength, resistance to sunlight, resistant to petrochemicals, unaffected by freeze/thaw cycles, straight sided, flush fit with sidewalk or grass, and be capable of anchor inserts to allow for mounting Cable Rack. CommBox shall be manufactured of a composite mixture of polymer and concrete; and, be reinforced by a heavy-weave fiberglass. All CommBoxes shall be open bottomed one-piece box construction with cover and Cable Rack. No stacking of box sections allowed. CommBox sizes shall be in accordance with the Standard Drawings.

CommBox (both box and cover) shall conform to all test provisions of ANSI/Society of Cable Telecommunication Engineers (SCTE) National Standard No. ANSI/SCTE 77 "*Specifications for Underground Enclosure Integrity*" for Application Tier 22. CommBoxes shall meet or exceed the Tier 22 structural load test requirements which has the following defined test values:

Vertical	*Design Load* =	22,500 lbs. {100.1 kN}
	Test Load =	33,750 lbs. {150.1 kN}
Lateral	*Design Load* =	800 lbs./sq. ft. {38.3 kPa}
	Test Load =	1,200 lbs./sq. ft. {57.5 kPa}

CommBox shall be reinforced by a heavy-weave fiberglass creating a material compressive strength of no less than 110 psi. Each CommBox shall be designed and tested to temperatures of -50˚F {-46˚C}.

2. Cable Rack.

CommBox shall include manufacturer recommended Cable Rack for storage of cable slack and splice closure(s). The Cable Rack shall be designed so it supports both the cable maintenance coils (while maintaining cable bend radius) and the splice closure such that they are not stressed while hanging on the rack. The Cable Rack shall also hold the cable and splice closure up off the bottom of the CommBox. The Cable Rack shall be non-corrosive metallic material (hot dipped galvanized steel, stainless steel or aluminum) with no sharp edges. The Contractor shall submit, for Engineer approval, the Cable Rack shop drawings/cut-sheets of the materials and installation.

3. CommBox Cover.

All CommBoxes shall be supplied with a heavy-duty cover that meets the ANSI/SCTE 77 application Tier rating requirements as defined in above "*Materials and Load Requirements*".

All covers shall be supplied with a minimum of two (2) stainless steel hex head bolts with stainless steel washers used to secure the cover to the CommBox.

CommBox covers shall be embossed on the outside of the Cover with "*FIBER OPTICS*" when used for fiber optic installations and "*ELECTRIC*" when used for electrical power service installations. CommBox covers shall have "*J*" hook slots (reference **ALDOT Index No. 72920**, **Standard Dwg. No. ITS-729-020**, "*CommBox Installation For Fiber Optic Cable And Conductors"*).

4. Grounding.

Where required per NEC for conductive optical fiber cables or electrical service conductors, CommBox shall require a grounding electrode (ground rod) installed within the CommBox and meet the Grounding requirements of this Specification.

5. Concrete Collar.

Each CommBox shall be surrounded by a minimum 12 in. wide x 6 in. deep concrete collar and shall include wire mesh.

The concrete mix used for concrete collar shall comply with the requirements of **Section 501** for Class A concrete and **Section 620**, unless otherwise shown on the Plans.

Reinforcing steel shall meet the requirements of **Section 502** and as shown on the Plans.

(f) Pull Box.

1. Materials.

Pull Box shall be manufactured of a minimum of 0.125 inch {3 mm} thick aluminum and be supplied with a screw-on cover (hinge optional). Exposed surfaces shall be treated with rust resistant material. Pull Box shall meet the requirements of NEMA Type 3R. Pull boxes shall have fixed external mounting brackets for structure mounting (4 total, 2 per side on opposite sides). Conduit penetrations shall be watertight through rigid hubs for the size conduit required on the Plans.

2. Cable Rack.

Pull Box shall include manufacturer recommended Cable Rack for storage of cable slack. The Cable Rack shall be designed so it supports the cable maintenance coils (while maintaining cable bend radius) such that they are not stressed while hanging on the rack. The Cable Rack shall also hold the cable up off the bottom of the Pull Box. The Cable Rack shall be non-corrosive metallic material (hot dipped galvanized steel, stainless steel or aluminum) with no sharp edges. The Contractor shall submit, for Engineer approval, the Cable Rack shop drawings/cut-sheets of the materials and installation.

3. Grounding.

Where required per NEC for conductive optical fiber cables or electrical service conductors, Pull Box shall require a grounding electrode (ground rod) installed and meeting the Grounding requirements of this Specification.

(g) Fiber Marker Post.

The Marker Post for fiber optic cable shall be of composite material and weigh less than 4 lbs. {1.8 kg}. All Fiber Marker Posts shall be dome designed for a minimum of twenty (20) year service life and shall include the manufacturer's tubular anchor system. Fiber marker post dimensions and installation shall be in accordance with the Standard Drawings. The fiber marker post shall be white, UV resistant and durable to extreme weather conditions. The dome area of the polyethylene post containing graphics shall be black text on orange background and as shown on the Standard Drawings. The graphics shall not fade, peel or chip and last the lifetime of the fiber marker post. The dome cover graphic system shall be Engineer approved prior to being printed; and, shall be printed on opposite sides of dome cover while maximizing the print space.

See corresponding Construction Section for fiber marker post label "*proof check*" sample and approval requirements.

(h) Frequency Locate Marker.

An electronic marker for detecting the CommBox shall be included. The electronic marker shall use the Telephone dedicated frequency (101.4 kHz). It shall be a passive device, requiring no batteries, with an RF field detectable with any standard marker locator. Working with a locator, the frequency locate marker shall indicate the marker's exact position within a five (5) feet diameter area.

(i) Surge Protection.

1. Coaxial Video Surge Protection.

Each video Surge-Protective Device shall provide inline overvoltage/overcurrent protection for a single coaxial cable. The video surge-protective device shall employ a hybrid technology of gas discharge tubes, silicon avalanche diode and current limiting components. Video surge-protective devices shall have the following features:

a. UL Listed UL 497B
b. Maximum voltage: 8 volts (16 volts peak-to-peak)
c. Frequency range: 0 to 10 MHz
d. 10kA nominal discharge (surge) current
e. 50/75 ohm (Ω) BNC connection
f. EMI attenuation: < 0.5 dB at 10 Hz
g. Designed for mounting on standard 35mm German Institute for Standardization (DIN) rail.
h. NEMA TS2 temperature rated

2. Ethernet Surge Protection.

Each Ethernet Surge-Protective Device shall provide inline overvoltage/overcurrent protection for an outdoor rated CAT5/5E/6/6A data/control cable. The data surge-protective device shall employ a hybrid technology of gas discharge tubes, silicon avalanche diode and current limiting components. Data surge-protective devices shall have the following features:

a. UL Listed UL 497B
b. Frequency range: 0 to 100 MHz
c. 100 A nominal discharge (surge) current
d. < 8V clamping voltage
e. 8P8C (a.k.a. type RJ45 “unkeyed”) modular jack connectors – 8 wire
f. Designed for mounting on standard 35mm DIN rail
g. NEMA TS2 temperature rated

3. Power over Ethernet (PoE) Surge Protection.

Each Power over Ethernet (PoE) Surge-Protective Device shall provide inline overvoltage/overcurrent protection for an outdoor rated CAT5/5E/6/6A data/control cable. The data surge-protective device shall employ a hybrid technology of gas discharge tubes, silicon avalanche diode and current limiting components. Data surge-protective devices shall have the following features:

a. UL Listed UL 497B
b. Frequency range: 0 to 100 MHz
c. 2kA nominal discharge (surge) current
d. 68 Vdc maximum continuous operating voltage
e. < 0.1db loss for 8P8C (a.k.a. type RJ45 “unkeyed”) modular jack connectors – 8 wire
f. Designed for mounting on standard 35 mm DIN rail
g. NEMA TS2 temperature rated

4. Data Surge Protection (Serial).

Each Data Surge-Protective Device shall provide inline overvoltage/overcurrent protection for a two-pair (4-wire + shield) serial data/control cable. The data surge-protective device shall employ a hybrid technology of gas discharge tubes, silicon avalanche diode and current limiting components. Data surge-protective devices shall have the following features:

a. UL Listed UL 497B
b. 10kA nominal discharge current
c. < 27V clamping voltage OR < 46V as required by the device being protected
d. 5 position cage clamp terminals for 24 AWG to 12 AWG conductor
e. Designed for mounting on standard 35 mm DIN rail
f. NEMA TS2 temperature rated

5. Power Surge Protection.

Each Power Surge-Protective Device shall provide inline overvoltage/overcurrent protection for a three conductor 120-volt AC power feed within an ITS Cabinet. The power surge-protective device shall employ a hybrid technology Metal Oxide Varistors (MOV) and thermal sensitive device for disconnecting power from the load after an MOV failure. Power surge-protective devices shall have the following features:

a. UL Listed UL 1449
b. 700 voltage protection rating
c. ≥ 40kA nominal discharge current per phase
d. Maximum load current: ≥ 50kA
e. Visual indicated for every MOV including neutral and ground
f. 5 position cage clamp terminals for 24 AWG to 12 AWG conductor
g. Designed for mounting on standard 35 mm DIN rail
h. NEMA TS2 temperature rated

6. Electrical Surge Protection.

A surge-protective device consisting of directly connected MOV shall be installed at the incoming electrical service lines and shall be located such that the connection leads are of minimum length. Conductor leads shall be cut to length to ensure quick reaction time. The Contractor shall connect the surge protector to the load side of the main disconnect in the controller cabinet. The surge-protective devices shall have the following features:

a. UL Listed UL 1449

b. 20kA I-nominal rating
c. Line-neutral, line-ground, and neutral-ground modes of protection
d. Directly connected MOVs exceeding 32mm in diameter from line-neutral, line-ground, and neutral-ground
e. Surge current rating shall equal or exceed 50kA per mode, 100kA per phase
f. Voltage Protection Rating shall not exceed 700V on any mode.
g. Each MOV shall include a thermal safety disconnector(s).
h. Gas Tubes or Spark Gaps shall not be accepted due to high initial clamp overshoot.
i. MOV's operational status shall be monitored via visual indicator, including neutral-ground.
j. One set of normally open, normally closed form C contacts for remote monitoring.
k. Unit shall be NEMA Type 4 rated for outdoor installation.

7. Field Management Unit Surge Protection.

A surge-protective device consisting of directly connected MOV shall be installed at cabinet locations at the incoming electrical service lines. The surge-protective device shall have the following features:

a. UL Listed UL 1449;
b. 20kA I-nominal rating;
c. Line-neutral, line-ground, neutral-ground, and line-line modes of protection;
d. Surge current rating shall equal or exceed 50kA per mode, 100kA per phase;
e. Voltage Protection Rating shall not exceed 600V for 208Y/120V or 1,000V for 480Y/277V;
f. Less than 1 ns response time;
g. Individually fused and thermally protected MOVs;
h. MOV shall be 34 mm square minimum;
i. Shall have diagnostic monitoring on every MOV;
j. MOV operational status shall be monitored via visual indicator, including neutral ground; and,
k. Unit shall be enclosed in a NEMA Type 4X enclosure.

(j) Uninterruptible Power Supply (UPS).

The Uninterruptible Power Supply/battery backup system (UPS system) shall be used for the management of power supplies to ITS devices. The UPS shall provide output power with user option to function as single, dual, or line interactive conversion. The UPS unit shall be field hardened. The UPS shall have trickle charge capabilities. The UPS shall provide backup power for a minimum of three days for permanent and ten days for portable highway advisory radios. If providing backup power for other ITS equipment as shown on the Plans, it shall be provided for a minimum of one hour. Batteries used for a power supply shall be sealed gel type in the quantity and location (separate enclosure from the ITS equipment) as shown on the Plans.

The UPS shall be monitored through a Graphical User Interface (GUI) capable of monitoring performance and alarms as well as provide system management. The UPS shall display battery status, input and output voltage, Amp hours, load, and run time.

DESCRIPTION	SPECIFICATION
Input Voltage: AC DC	 90 - 150 Vac 48 Vdc
Output Voltage: AC DC	 120 Vac, true sine wave 12, 24, 48 Vdc
Power Regulation	± 4%
Response Time	< 5 ms
Output Power	Rated for intended load
Connection Type	Dry Contacts, Type B receptacle
Temperature Operating Range	-40˚F to 165˚F {-40˚C to 74˚C}
Humidity Operating Range	0 - 95% non-condensing
Housing	Free standing or rack mountable (as shown on the Plans)
Communication Ports	Ethernet SNMP, RS-232
Audible Alarm	Utility power interruption, inverter failure, low battery

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