**BENEFIT-COST ANALYSIS OF SAFETY IMPROVEMENTS IN CONJUNCTION WITH 3R PROJECTS ON RURAL TWO-LANE HIGHWAYS**

| ROADWAY DATA | |
|---|---|
| Section Length (mi) | 0.189 |
| AADT (veh/day) | 2,050 |
| Terrain | Rolling |
| Pavement Type | Flexible |

| ALIGNMENT DATA | |
|---|---|
| Enter average curve data | ◉ |
| *Enter specific curve data | ○ |

*Use this if improving superelevation

| EXISTING CROSS SECTION | |
|---|---|
| Lane Width (ft) | 10.0 ft |
| Shoulder Width (ft) | 4 ft |
| Shoulder Type | Unpaved |
| Roadside Slope | 1V:2H |
| Centerline Rumble Strip | No |
| Shoulder Rumble Strip | No |

| CRASH HISTORY | | |
|---|---|---|
| Consider existing crash history? | | |
| Yes | ◉ | No ○ |

| RESULTS | Calculated | User Supplied | Value Used |
|---|---|---|---|
| PV MODIFIED TOTAL COST ($)* | $28,125 ◉ | ○ | $28,125 |

*total cost minus milling and resurfacing cost for existing traveled way

| | | | |
|---|---|---|---|
| ANNUAL SAFETY BENEFIT ($) | $1,044 | BENEFIT-COST RATIO | 0.393 |
| PRESENT VALUE OF SAFETY BENEFIT ($) | $11,058 | NET BENEFIT ($) | -$17,067 |

slope flattening is not cost beneficial.

| AVERAGE CURVE DATA | |
|---|---|
| % of Section Length on Curves | 0.00% |
| Typical Curve Radius (ft) | 1000 ft |
| Number of Curves on Section | 0 |
| Presence of Spiral Transitions | No |

| CRASH DATA | |
|---|---|
| Crash History Period (yrs) | 5 |
| Total Fatal-and-Injury Crashes | 5 |
| Total Property-Damage-Only Crashes | 0 |

← Estimated # crashes in this section only.

| Alternatives to Consider | Consider for Improvement | User Selection | Value Selected |
|---|---|---|---|
| Lane Width (ft) | ☐ | | Retain Lane Width |
| Shoulder Width (ft) | ☐ | | Retain Shoulder Width |
| Shoulder Type | ☐ | | Unpaved Shoulder |
| Roadside Slope | ☑ | 1V:3H | 1V:3H |

Note: Shoulder scoring was selected and included in application. It was cost beneficial when analyzed.

| | | | | |
|---|---|---|---|---|
| Service Life (yrs) | Slope Flattening | 20 yrs ◉ | 10 yrs ○ | 20 yrs |
| | Lane Widening | | | |
| | Shoulder Widening | | | |
| | Rumble Strip Install | 20 yrs ◉ | 10 yrs ○ | 20 yrs |
| | Striping/Delineation | 5 yrs ◉ | 10 yrs ○ | 5 yrs |
| | Superelevation Restoration | 20 yrs ◉ | 10 yrs ○ | 20 yrs |
| Crash Cost by Severity ($/crash) | Fatal | $ 4,008,900 ○ | $ 1,571,053 ◉ | $ 1,571,053 |
| | Disabling Injury | $ 216,000 ○ | $ 1,571,053 ◉ | $ 1,571,053 |
| | Evident Injury | $ 79,000 ○ | $ 128,959 ◉ | $ 128,959 |
| | Possible Injury | $ 44,900 ○ | $ 128,959 ◉ | $ 128,959 |
| | Property Damage Only | $ 7,400 ○ | $ 9,624 ◉ | $ 9,624 |

| SAFETY ELEMENTS | | Default | User Supplied | Values Used |
|---|---|---|---|---|
| Rural 2-lane SPF | | HSM ◉ | =f(AADT, L) ○ | HSM SPF |
| Calibration Factor | | 1.00 ◉ | ○ | 1.00 |
| | | ○ | ◉ | |
| Crash Type Proportion | **Single-vehicle crashes** | | | |
| | Collision with animal | 12.1% | 5.0% | 5.0% |
| | Collision with bicycle | 0.2% | 0.1% | 0.1% |
| | Collision with pedestrian | 0.3% | 0.3% | 0.3% |
| | Overturned | 2.5% | 4.7% | 4.7% |
| | Ran off road | 52.1% | 46.1% | 46.1% |
| | Other single-vehicle crash | 2.1% | 3.2% | 3.2% |
| | **Multiple-vehicle crashes** | | | |
| | Angle collision | 8.5% | 15.8% | 15.8% |
| | Head-on collision | 1.6% | 2.4% | 2.4% |
| | Rear-end collision | 14.2% | 15.8% | 15.8% |
| | Sideswipe collision | 3.7% | 5.6% | 5.6% |
| | Other multi-vehicle collision | 2.7% | 1.0% | 1.0% |
| | **Total crashes** | 100.0% | 100.0% | 100.0% |
| | | ○ | ◉ | |
| Crash Severity Proportion | Fatal (K) | 1.3% | 1.5% | 1.5% |
| | Disabiling Injury (A) | 5.4% | 9.2% | 9.2% |
| | Evident Injury (B) | 10.9% | 13.8% | 13.8% |
| | Possible Injury (C) | 14.5% | 6.4% | 6.4% |
| | Property Damage Only (PDO) | 67.9% | 69.0% | 69.0% |
| | **Total crashes** | 100.0% | 100.0% | 100.0% |

Alabama Statistics Provided by Design Bureau

| PROJECT COST CALCULATOR | | Width | Quantity | Unit | Unit Cost | Cost |
|---|---|---|---|---|---|---|
| PAVEMENT AND BASE | Milling | 20.00 ft | 0.00 | sq yd | $3.16 | $0.00 |
| | Resurfacing | 20.00 ft | 0.00 | TON | $100.00 | $0.00 |
| | Widening | 0.00 ft | 0.00 | TON | $100.00 | $0.00 |
| | Base | 0.00 ft | 0.00 | sq yd | $17.12 | $0.00 |
| | Shoulder Milling | 0.00 ft | 0.00 | sq yd | $3.16 | $0.00 |
| | Shoulder Resurfacing | 0.00 ft | 0.00 | TON | $100.00 | $0.00 |
| | Shoulder Widening | 4.00 ft | 0.00 | cu yd | $21.26 | $0.00 |
| | Shoulder Base | 4.00 ft | 0.00 | sq yd | $17.12 | $0.00 |
| | Unpaved Shoulder | | 0.00 | TON | $49.29 | $0.00 |
| EARTHWORK | Embankment | | 375.00 | cu yd | $50.00 | $18,750.00 |
| RUMBLE STRIPS | Centerline | | | ft | $0.50 | $0.00 |
| | Shoulder | | 0.00 | ft | $0.40 | $0.00 |
| PAVEMENT MARKINGS | Improvement (Includes Edgeline) | 4.0 in | 0.00 | ft | $0.66 | $0.00 |
| DELINEATORS | Improvement | | 0 | each | $60.00 | $0.00 |
| SUPERELEVATION IMPROVEMENT | Curve 1 Resurfacing | 20.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 2 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 3 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 4 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 5 Resurfacing | 22.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 6 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 7 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 8 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 9 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| | Curve 10 Resurfacing | 0.00 ft | 0.00 | TON | $110.00 | $0.00 |
| RIGHT-OF-WAY | Acquisition (Includes Pass Lns) | 6.00 ft | 0.00 | acre | $40,000 | $0.00 |

| | |
|---|---|
| INITIAL SUBTOTAL | $18,750.00 |
| PW of SUBTOTAL (20 yrs) | $18,750.00 |

| | | % | Initial Cost | PW Cost |
|---|---|---|---|---|
| INCIDENTALS | Drainage | 0.0% | $0.00 | $0.00 |
| | Erosion Control | 50.0% | $9,375.00 | $9,375.00 |
| | Traffic Control | 0.0% | $0.00 | $0.00 |
| | Signing and Pavement Marking | 0.0% | $0.00 | $0.00 |

← Silt Fence
Silt Fence removal
Seeding
Mulching

| | |
|---|---|
| INITIAL TOTAL COST | $28,125.00 |
| PW of TOTAL (20 yrs) | $28,125.00 |

| | |
|---|---|
| INITIAL MODIFIED COST* | $28,125.00 |
| PW of MOD. COST (20 yrs) | $28,125.00 |

*Total cost plus ROW cost minus milling and resurfacing of existing traveled way

| ROADSIDE SLOPE CMF | | | |
|---|---|---|---|
| EXISTING | | IMPROVED | |
| Roadside Slope | 1V:2H | Roadside Slope | 1V:3H |
| CMF for Total Crashes | 1.01 | CMF for Total Crashes | 1.00 |

From Figure 3-7:

4.5' slope depth = 10.125 SF/FT of length

$10.125\ SF * 1000\ FT = \frac{10{,}125\ FT^3}{27} =$ **375 CY Borrow**

Example B/C Analysis
Clear Zone Slope Flattening

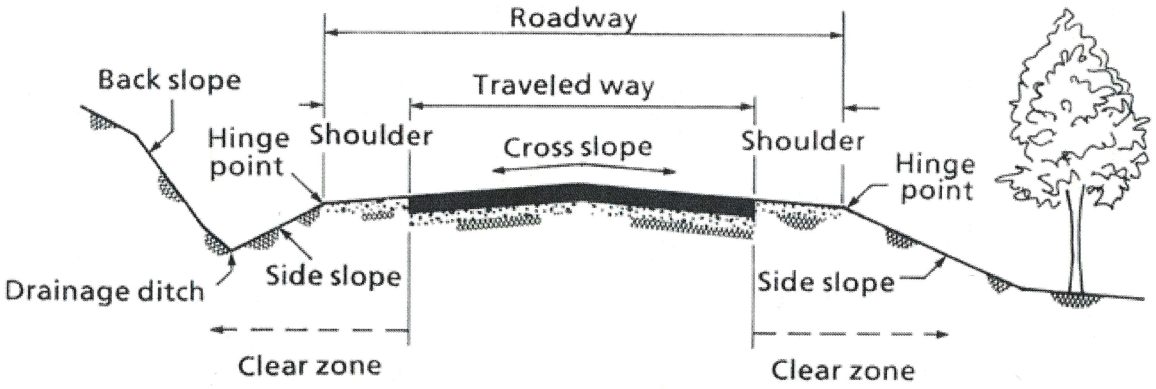
# Side Slopes and Clear Zones

**Guideline 9:** The designer should develop consistent procedures for evaluating and improving roadside features with the following objectives:

- The desirable clear zone width for 3R projects shall be as defined in the AASHTO publication, *A Policy on Geometric Design of Highways and Streets, 2018 7th Edition*, based upon the setting and functional classification of the road or street (Chapters 5, 6, and 7).

7-10' For 45MPH or less

**Clear zone illustration**




| | |
|---|---|
| Hinge Point | Point where the slope rate changes. |
| Clear Zone | A traversable area that starts at the edge of the traffic lane, includes the shoulder, and extends laterally a sufficient distance to allow a driver to stop or return to the road before encountering a hazard or overturning |

Figure 3-6: Clear Zone Illustration

- A clear zone of any width should provide some contribution to safety; thus the designer should evaluate providing clear zone improvements based upon a benefit/cost analysis utilizing Spreadsheet Tool 1. Most often this will involve flattening side slopes or removing roadside obstacles. The recommended method is to isolate the section that is to be improved (700' of slope flattening from 2:1 to 3:1 for example) and analyze its benefit and cost separately from any other project improvements. If more information or assistance is needed, please contact the Design Section of the Local Transportation Bureau. Please see the following figure with example calculations concerning the cost of flattening side slopes steeper than 3:1:

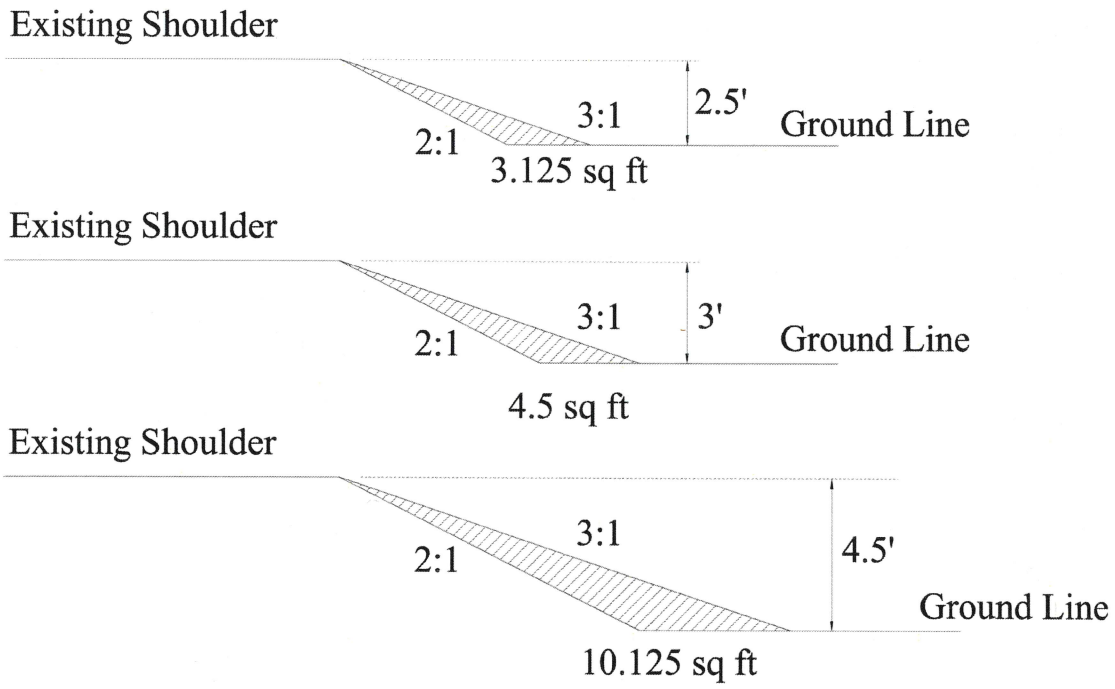



Figure 3-7: Flattening 2:1 Side Slopes to 3:1 with Estimated Areas of Fill

**Example Calculations**

Utilizing the figure above, the cost of flattening a 2:1 side slope to 3:1 with an embankment height of 3 ft over a 700 ft long section would cost:

4.5 sq ft X 700 ft = 3,150 cu ft = 116.67 cu yds
116.67 cu yds X $21.26/cu yd = **$2,480.40**

**Note**: The price of borrow excavation used in this example is based upon average ALDOT bid history prices and should be updated/revised as necessary.