

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

ROADWAY DATA	
Section Length (mi)	4.701
AADT (veh/day)	1,800
Terrain	Rolling
Pavement Type	Flexible

ALIGNMENT DATA	
Enter average curve data	<input type="checkbox"/>
*Enter specific curve data	<input checked="" type="checkbox"/>

*Use this if improving superelevation

EXISTING CROSS SECTION	
Lane Width (ft)	10.0 ft
Shoulder Width (ft)	3 ft
Shoulder Type	Unpaved
Roadside Slope	1W:3H
Centerline Rumble Strip	No
Shoulder Rumble Strip	No

CRASH HISTORY	
Consider existing crash history?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>

Alternatives to Consider	Consider for Improvement	Value Selected
	User Selection	

RESULTS		Calculated	User Supplied	Value Used
PV MODIFIED TOTAL COST (\$)*	\$930,586	<input checked="" type="checkbox"/>	<input type="checkbox"/>	\$930,586
*Total cost minus milling and resurfacing cost for existing traveled way				
ANNUAL SAFETY BENEFIT (\$)	\$24,324			
PRESENT VALUE OF SAFETY BENEFIT (\$)	\$257,690			
		BENEFIT-COST RATIO	0.277	
		NET BENEFIT (\$)	-5672,895	

← Not cost beneficial.

Note: Selected 10 curves that met the lowest design speed to analyze. Had to make some assumptions since curve data was unknown. See notes.

SPECIFIC CURVE DATA									
Number of Curves in Roadway Section		10							
Maximum Superelevation Rate (emax)		8%							
Design Speed (mph)		45 mph							
Curve #	Curve Length (mi)	Transition Length (mi)	Radius (ft)	Spiral	Existing e (%)	Consider for Improvement	Improved e (%)		
1	0.256 mi	0.000 mi	933.00 ft	No	3.4%	Yes	7.0%		
2	0.256 mi	0.000 mi	933.00 ft	No	4.4%	Yes	7.0%		
3	0.256 mi	0.000 mi	933.00 ft	No	4.4%	Yes	7.0%		
4	0.256 mi	0.000 mi	933.00 ft	No	4.4%	Yes	7.0%		
5	0.256 mi	0.000 mi	933.00 ft	No	4.4%	Yes	7.0%		
6	0.256 mi	0.000 mi	933.00 ft	No	4.4%	Yes	7.0%		
7	0.256 mi	0.000 mi	933.00 ft	No	5.2%	Yes	7.0%		
8	0.256 mi	0.000 mi	933.00 ft	No	5.2%	Yes	7.0%		
9	0.256 mi	0.000 mi	933.00 ft	No	5.2%	Yes	7.0%		
10	0.256 mi	0.000 mi	933.00 ft	No	5.2%	Yes	7.0%		

CRASH DATA	
Crash History Period (yrs)	3
Total Fatal-and-Injury Crashes	10
Total Property-Damage-Only Crashes	0

Before FI Crashes	#####
Before PDO Crashes	#####
After FI Crashes	#####
After PDO Crashes	#####
Reduced FI Crashes	#####
Reduced PDO Crashes	#####

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

SAFETY ELEMENTS	Default	User Supplied	Values Used	
Rural 2-lane SPF	HSM <input checked="" type="radio"/>	=f(AADT, L) <input type="radio"/>	HSM SPF	
Calibration Factor	1.00 <input checked="" type="radio"/>	<input type="radio"/>	1.00	
Crash Type Proportion	<input type="radio"/>	<input checked="" type="radio"/>		
	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	<input type="radio"/>	<input checked="" type="radio"/>		
	Fatal (K)	1.3%	1.5%	1.5%
	Disabling 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%	

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		0.00	cu yd	\$15.00	\$0.00
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	1040.60	TON	\$110.00	\$114,466.00
	Curve 2 Resurfacing	20.00 ft	820.15	TON	\$110.00	\$90,216.50
	Curve 3 Resurfacing	20.00 ft	820.15	TON	\$110.00	\$90,216.50
	Curve 4 Resurfacing	20.00 ft	820.15	TON	\$110.00	\$90,216.50
	Curve 5 Resurfacing	22.00 ft	820.15	TON	\$110.00	\$90,216.50
	Curve 6 Resurfacing	20.00 ft	820.15	TON	\$110.00	\$90,216.50
	Curve 7 Resurfacing	20.00 ft	637.36	TON	\$110.00	\$70,109.60
	Curve 8 Resurfacing	20.00 ft	637.36	TON	\$110.00	\$70,109.60
	Curve 9 Resurfacing	20.00 ft	637.36	TON	\$110.00	\$70,109.60
	Curve 10 Resurfacing	20.00 ft	637.36	TON	\$110.00	\$70,109.60
RIGHT-OF-WAY	Acquisition (Includes Pass Lns)	0.00 ft	0.00	acre	\$40,000	\$0.00

INITIAL SUBTOTAL	\$845,986.90
PW of SUBTOTAL (20 yrs)	\$845,986.90

		%	Initial Cost	PW Cost
INCIDENTALS	Drainage	0.0%	\$0.00	\$0.00
	Erosion Control	10.0%	\$84,598.69	\$84,598.69
	Traffic Control	0.0%	\$0.00	\$0.00
	Signing and Pavement Marking	0.0%	\$0.00	\$0.00

← Silt Fence
Silt Fence rem.
seeding
mulching

INITIAL TOTAL COST	\$930,585.59
PW of TOTAL (20 yrs)	\$930,585.59

INITIAL MODIFIED COST*	\$930,585.59
PW of MOD. COST (20 yrs)	\$930,585.59

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

ALDOT Std. Dwg. 68016 (SSEC-1)

1 @ 25 MPH

5 @ 30 MPH

4 @ 35 MPH

Superelevation Rate Table ($e_{max} = 8\%$)

2011 Green Book Table 3-10b (Sheet 3-47)

e (%)	V _a = 15 mph		V _a = 20 mph		V _a = 25 mph		V _a = 30 mph		V _a = 35 mph		V _a = 40 mph		V _a = 45 mph		V _a = 50 mph		V _a = 55 mph		V _a = 60 mph		V _a = 65 mph		V _a = 70 mph		V _a = 75 mph		V _a = 80 mph		
	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	
NC	932	1640	2370	3240	4260	5410	6710	8150	9720	11500	12900	14500	16100	17800	19500	21200	22900	24600	26300	28000	29700	31400	33100	34800	36500	38200	39900	41600	
RC	676	1190	1720	2370	3120	3970	4930	5990	7150	8440	9510	10700	12000	13300	14600	15900	17200	18500	19800	21100	22400	23700	25000	26300	27600	28900	30200	31500	
2.2	605	1070	1550	2130	2800	3570	4440	5400	6450	7620	8660	9660	10660	11660	12660	13660	14660	15660	16660	17660	18660	19660	20660	21660	22660	23660	24660	25660	26660
2.4	546	959	1400	1930	2540	3240	4030	4910	5870	6930	7830	8810	9850	10850	11850	12850	13850	14850	15850	16850	17850	18850	19850	20850	21850	22850	23850	24850	25850
2.6	496	872	1280	1760	2320	2960	3690	4490	5370	6350	7180	8090	9050	10000	10950	11900	12850	13800	14750	15700	16650	17600	18550	19500	20450	21400	22350	23300	24250
2.8	453	796	1170	1610	2130	2720	3390	4130	4950	5850	6630	7470	8370	9340	10300	11250	12200	13150	14100	15050	16000	16950	17900	18850	19800	20750	21700	22650	23600
3.0	415	730	1070	1480	1960	2510	3130	3820	4580	5420	6140	6930	7780	8700	9600	10500	11400	12300	13200	14100	15000	15900	16800	17700	18600	19500	20400	21300	22200
3.2	382	672	985	1370	1820	2330	2900	3550	4250	5040	5720	6460	7260	8130	9000	9870	10740	11610	12480	13350	14220	15090	15960	16830	17700	18570	19440	20310	21180
3.4	352	620	911	1270	1690	2170	2700	3300	3970	4700	5350	6050	6800	7620	8450	9280	10110	10940	11770	12600	13430	14260	15090	15920	16750	17580	18410	19240	20070
3.6	324	572	845	1180	1570	2020	2520	3090	3710	4400	5010	5680	6400	7180	7960	8740	9520	10300	11080	11860	12640	13420	14200	14980	15760	16540	17320	18100	18880
3.8	300	530	784	1100	1470	1890	2360	2890	3480	4140	4710	5350	6030	6780	7530	8280	9030	9780	10530	11280	12030	12780	13530	14280	15030	15780	16530	17280	18030
4.0	277	490	729	1030	1370	1770	2220	2720	3270	3890	4450	5050	5710	6420	7130	7840	8550	9260	9970	10680	11390	12100	12810	13520	14230	14940	15650	16360	17070
4.2	255	453	678	955	1280	1660	2080	2560	3080	3670	4200	4780	5410	6090	6800	7510	8220	8930	9640	10350	11060	11770	12480	13190	13900	14610	15320	16030	16740
4.4	235	418	630	893	1200	1560	1960	2410	2910	3470	3980	4540	5140	5800	6510	7220	7930	8640	9350	10060	10770	11480	12190	12900	13610	14320	15030	15740	16450
4.6	215	384	585	834	1130	1470	1850	2280	2750	3290	3770	4310	4890	5530	6240	6950	7660	8370	9080	9790	10500	11210	11920	12630	13340	14050	14760	15470	16180
4.8	193	349	542	779	1060	1390	1750	2160	2610	3120	3590	4100	4670	5280	5990	6700	7410	8120	8830	9540	10250	10960	11670	12380	13090	13800	14510	15220	15930
5.0	172	314	499	727	991	1310	1650	2040	2470	2960	3410	3910	4460	5050	5640	6230	6820	7410	8000	8590	9180	9770	10360	10950	11540	12130	12720	13310	13900
5.2	154	284	457	676	929	1230	1560	1930	2350	2820	3250	3740	4260	4840	5420	6000	6580	7160	7740	8320	8900	9480	10060	10640	11220	11800	12380	12960	13540
5.4	139	258	420	627	870	1160	1480	1830	2230	2680	3110	3570	4090	4640	5190	5740	6290	6840	7390	7940	8490	9040	9590	10140	10690	11240	11790	12340	12890
5.6	126	236	387	582	813	1090	1390	1740	2120	2550	2970	3420	3920	4460	4990	5520	6050	6580	7110	7640	8170	8700	9230	9760	10290	10820	11350	11880	12410
5.8	115	216	358	542	761	1030	1320	1650	2010	2430	2840	3280	3760	4290	4810	5340	5870	6400	6930	7460	7990	8520	9050	9580	10110	10640	11170	11700	12230
6.0	105	199	332	506	713	965	1250	1560	1920	2320	2710	3150	3620	4140	4640	5140	5640	6140	6640	7140	7640	8140	8640	9140	9640	10140	10640	11140	11640
6.2	97	184	308	472	669	909	1180	1480	1820	2210	2600	3020	3480	3990	4490	4990	5490	5990	6490	6990	7490	7990	8490	8990	9490	9990	10490	10990	11490
6.4	89	170	287	442	628	857	1110	1400	1730	2110	2490	2910	3360	3850	4340	4830	5320	5810	6300	6790	7280	7770	8260	8750	9240	9730	10220	10710	11200
6.6	82	157	267	413	590	808	1050	1330	1650	2010	2380	2790	3240	3720	4190	4660	5130	5600	6070	6540	7010	7480	7950	8420	8890	9360	9830	10300	10770
6.8	76	146	248	386	553	761	990	1260	1560	1910	2280	2690	3120	3560	4000	4440	4880	5320	5760	6200	6640	7080	7520	7960	8400	8840	9280	9720	10160
7.0	70	135	231	360	518	716	933	1190	1480	1820	2180	2580	3010	3480	3940	4400	4860	5320	5780	6240	6700	7160	7620	8080	8540	9000	9460	9920	10380
7.2	64	125	214	336	485	672	878	1120	1400	1720	2070	2470	2900	3370	3830	4290	4750	5210	5670	6130	6590	7050	7510	7970	8430	8890	9350	9810	10270
7.4	59	115	198	312	451	628	822	1060	1320	1630	1970	2350	2780	3250	3710	4170	4630	5090	5550	6010	6470	6930	7390	7850	8310	8770	9230	9690	10150
7.6	54	105	182	287	417	583	765	980	1230	1530	1850	2230	2650	3120	3580	4040	4500	4960	5420	5880	6340	6800	7260	7720	8180	8640	9100	9560	10020
7.8	48	94	164	261	380	533	701	901	1140	1410	1720	2090	2500	2970	3430	3890	4350	4810	5270	5730	6190	6650	7110	7570	8030	8490	8950	9410	9870
8.0	38	76	134	214	314	444	587	758	960	1200	1480	1810	2210	2670	3130	3590	4050	4510	4970	5430	5890	6350	6810	7270	7730	8190	8650	9110	9570

25 MPH

30 MPH

35 MPH

45 MPH

Since curve data is unknown, assume $R = 933'$ and $L = 1350'$ (0.256) For all curves.

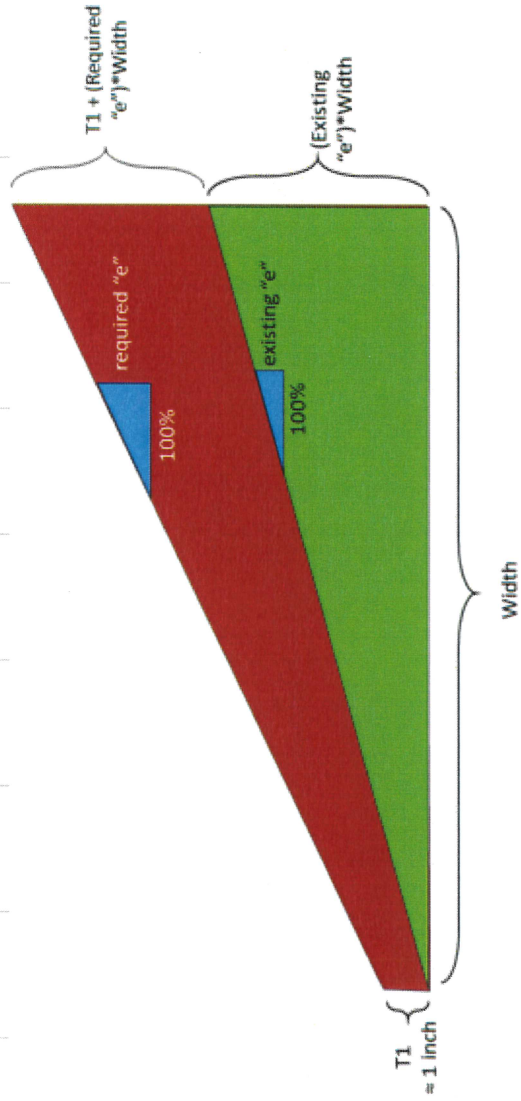
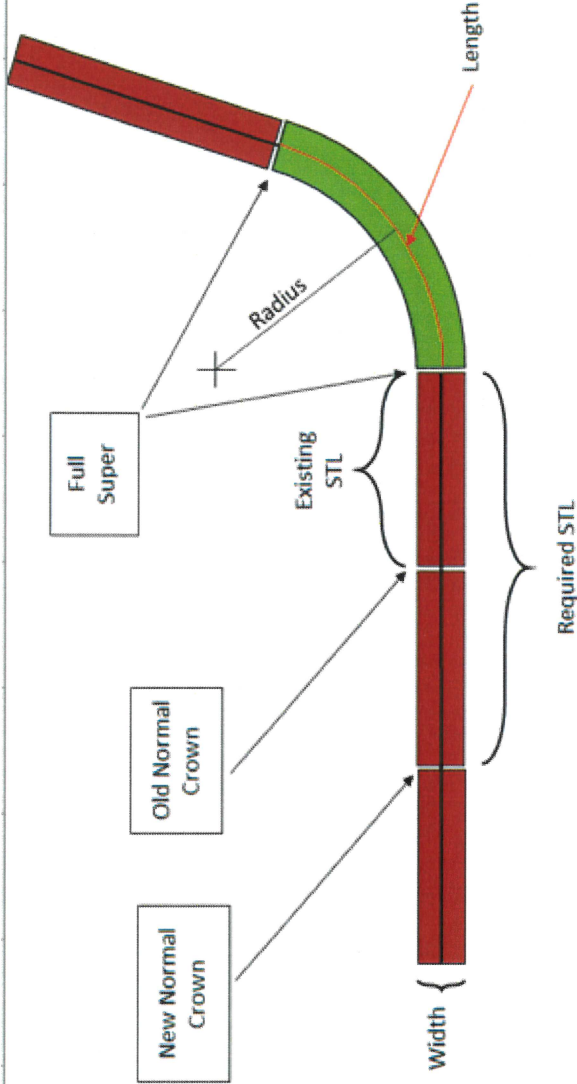
Existing e	3.4	Percent
Required e	7	Percent
Curve Length	1350	feet
Required STL		feet
Existing STL		feet
Radius	933	feet
Width	20	feet

Tonnage 1040.60 Tons

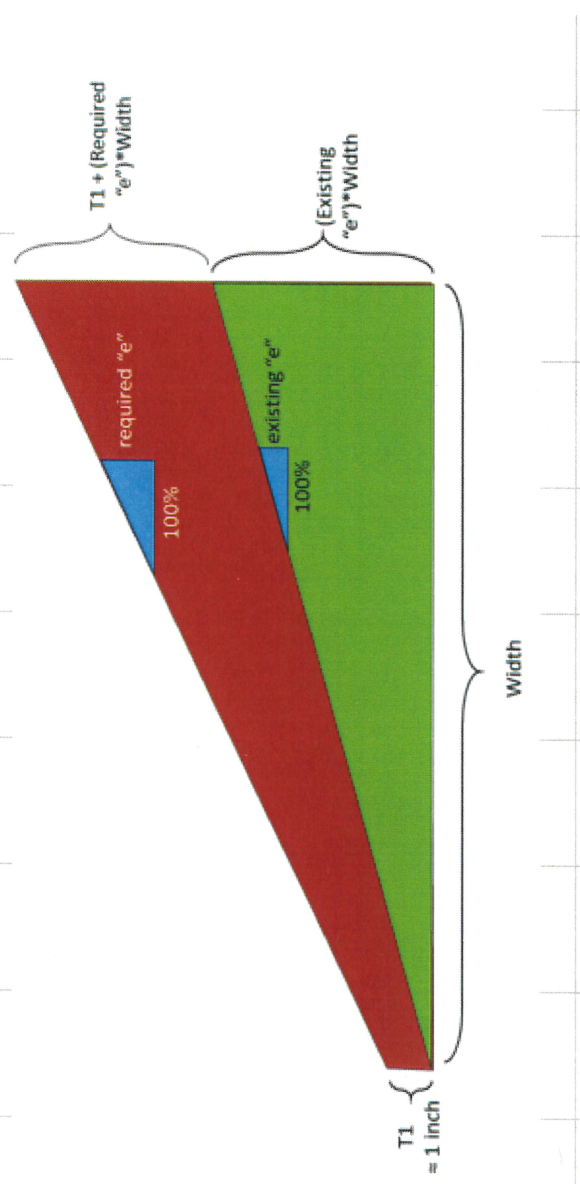
LEGEND:

Input
Optional Input
Calculated

NOTE: Optional Input is not required but it must be left blank if it is not being used.



Existing e	4.4	Percent
Required e	7	Percent
Curve Length	1350	feet
Required STL		feet
Existing STL		feet
Radius	933	feet
Width	20	feet
Tonnage	820.15	Tons
LEGEND:		
Input		
Optional Input		
Calculated		



NOTE: Optional Input is not required but it must be left blank if it is not being used.

1	Existing e	5.2	Percent
2	Required e	7	Percent
3	Curve Length	1350	feet
4	Required STL		feet
5	Existing STL		feet
6	Radius	933	feet
7	Width	20	feet
9			
10	Tonnage	637.36	Tons

44	LEGEND:
45	Input
46	Optional
47	Input
48	Calculated

50 NOTE: Optional Input is not
 51 required but it must be left
 52 blank if it is not being used.

