Montana Department of Transportation
PO Box 201001
Helena, MT 59620-1001

Memorandum

To: Lesly Tribelhorn, P.E.
Highways Engineer

From: Damian Krings, P.E. DMK
Road Design Engineer

Date: December 19, 2018

Subject: STPS 203-1(15)4
North of Stevensville-North
UPN 6138000
Work Type 140 - Reconstruction – without added capacity

Copied to John Hart

Executive Summary

The proposed scope is to reconstruct 6.1± miles of Secondary 203 (Eastside Highway) in Ravalli County to generally meet the design criteria for a rural major collector (Secondary System). The project limits extend from Reference Post (RP) 4.08 to 10.15.

We are seeking design exception approval to the following design criteria for a 60-mph design speed:

Horizontal alignment:

- The minimum radius is 1,200 feet. We propose spiral curves with lesser radii at the following locations (RP refers to Reference Post):

  RP 4.60: 590 feet
  RP 5.05: 625 feet
  RP 5.19: 625 feet

Two-Way-Left-Turn-Lane Width:

- The minimum width for rural areas is 14 feet. We propose a TWLTL width of 12 feet.

Shoulder Width:

- The minimum shoulder width is 8 feet, given the current ADT (> 3000) and the DHV (> 400). We propose a 4-ft. shoulder along the three segments where a three-lane configuration is proposed: RP 4.08 to 6.12, RP 7.11 to 9.13, and RP 9.88 to 10.15. The shoulder width will be 10 feet along the two segments where a two-lane configuration is proposed: (RP 6.12 to 7.11 and RP 9.13 to 9.88),

Fill slopes: We will strive to provide standard slopes, but we expect the following exceptions will be required along relatively short, intermittent locations:

Standard	Proposed
0 to 10' fill - 6:1	3:1 and flatter
10' to 20' fill - 4:1	1½:1 and flatter
20' to 30' fill - 3:1	1½:1 and flatter
>30' fill - 2:1	1½:1

Ditch Section: We propose a v-ditch with a 6:1 inslope 13 feet wide and backslopes that may vary from standard. The non-standard backslopes are proposed where needed to limit impacts to sensitive features and/or to limit right-of-way acquisition.

Standard	Proposed
0' to 5' cut - 5:1	3:1 or 4:1
5' to 10' cut - 4:1	2:1 or 3:1
10' to 15' cut - 3:1	2:1 and steeper
15' to 20' cut - 2:1	2:1 and steeper
> 20' cut - 1½:1	½:1 or flatter

Clear Zone – from edge driving lane (EDL - no correction for outside of curve)

Fill slope	Standard	Proposed (minimum)
6:1	30'	24'
4:1	44'	19'

Ditch (6:1/4:1 v-ditch)	Standard	Proposed (minimum)
	30'	25'

Proposed Project

A. Description and Scope of Work

The proposed scope is to reconstruct the horizontal and vertical alignments to meet 60 mph design criteria, except for two existing horizontal curves. The total reconstruction scope allows more flexibility to alter the horizontal and vertical alignments to provide acceptable connections to public road intersections and to avoid/minimize impacts to sensitive features identified during the design process.

The work will include clearing, grading, drainage, gravel, plant mix surfacing, signing, striping, fencing, and other miscellaneous items. Extensive right-of-way acquisition and utility relocation will be required.

The proposed 44-ft. paved width will be configured with three lanes (two-12-ft. driving lanes, a 12-ft. TWLTL, and two 4-ft. shoulders) along three segments and will be configured with two lanes (two-12-ft. driving lanes, and two 10-ft. shoulders) along two other segments. Other features will include new drainage pipes, some of which will be upsized to allow wildlife passage; upgraded guardrail, and rumble strips.

B. Purpose and Need

The purpose of the project is to upgrade the facility along the existing corridor to provide needed improvements in safety and operation to accommodate the heavy projected motor vehicle volumes, and to provide a safer facility for other users, especially bicyclists. The needed improvements will address the more prevalent crash types, including lane-departure, animal- vehicle collisions, and intersection-related crashes.

C. Public perception

The project's reception by the public has been mixed. Many who drive through the project regularly are supportive, although they may have differing views on the design details proposed. Most adjacent landowners who have commented generally support the project, but many are concerned about potential impacts to their properties. A few have expressed outright opposition to the project. We believe the proposed design

strikes a good balance between the need to improve the road for the traveling public and our desire to limit impacts to adjacent private property.

Existing Conditions

A. Project Location and Roadway Character

Secondary- 203 ("Eastside Highway") is in Ravalli County. It begins at the junction with Secondary 269 in Stevensville and ends in Florence at US 93. The project begins at RP 4.075, about four miles north of Stevensville, and about 200 feet south of the intersection of Wildfowl Lane and Moiese Lane. It extends northerly 6.1± miles to RP 10.145±, about 300 feet north of the intersection of Huckleberry Lane. The end of this project will tie to the beginning of BR-STPS 203 1-(11)10 Florence – East [4854], construction of which was substantially completed in 2015.

Secondary-203 (Eastside Highway) is functionally classified as a Major Collector. It passes through level to rolling rural terrain. There are numerous county roads, private roads, and private approaches intersecting S-203 within the project limits.

The existing land use is a mixture of large farm/ranch operations and small residential lots that have been subdivided out of larger agricultural properties in the last 30 years or so. We expect this trend to continue in the future.

Existing right-of-way widths are typically 20 to 60 feet per side throughout the project. There are several sections where the right-of-way widths are 100 to 150 feet to accommodate large cut or fill sections. Proposed right-of-way widths will generally be 60 to 80 feet per side with several sections extending to 100 to 110 feet. We anticipate we will need to acquire approximately 35 to 40 acres to accommodate our proposed widened roadway.

The Lee Metcalf National Wildlife Refuge is located west of S-203 between the highway and the Bitterroot River. The refuge is directly adjacent to S-203 between RP 6.2± and 7.1±.

As-built plan information is not readily available from RP 3.032 to RP 4.808, a county construction project reportedly built in 1945. The as-built plan information we do have is listed below:

Reference Post (RP)	As-Built Stationing	Project Number	Year
4.961 to 5.495	255+86.5 to 286+79.9	S-120(1)	1955
5.495 to 9.90	286+79.9 to 517+00±	S-170(1)	1955

According to the TIS Roadlog, the original surfacing on the county-constructed segment consisted of 0.25' of base course. It was subsequently covered with road mix bituminous surfacing. For the rest of the project, the original surfacing included 0.58' of compacted select borrow base course, 0.25' of top cushion course, 0.17'of road mix bituminous surfacing, and seal and cover.

Thin-lift overlays (< 0.20') were placed on Secondary 203 in1993 from RP 0 to 4.808 under RTS 203-1(2)0, Stevensville Northeast [2227], and in 1995 from RP 4.808 to 11.963 under RTS 203-1(3)5, Florence –South [2664.]

The current roadway width is 24 feet consisting of two 12-ft. travel lanes and no shoulders. Surfacing inslopes are 4:1.

Existing fill slopes less than 5 feet are 4:1 and fills greater than 5 feet have 1.5:1 slopes. Embankments 5 to 10 feet high were widened about 4 feet and those over 10 feet were widened 5 feet. Gravel was placed atop the widened embankments flush with the top of the cushion course.

Existing ditch sections have 4:1 inslopes that extend to 12 feet beyond the edge of driving lane, and a 10:1 ditch bottom 10 to 20 feet wide. Backslopes for cuts less than 5 feet are 5:1, cuts between 5 and 10 feet have 3:1 backslopes, and backslopes for cuts over 10 feet are 1.5:1.

All of the horizontal curves, except the two curves at RP 4.6 and RP 5.1, have radii well above the 60-mph design speed minimum of 1,200 feet. None of the curves have spiral transitions.

We do not have as-builts for the horizontal curve at RP 4.6, but graphical inspection of the photogrammetric mapping and cross-sections indicates its radius is about 210 feet and its superelevation is 8%. The 210-ft. radius is slightly less than the minimum radius of 220 feet for a 30-mph design (see Fig. 9.3A of RDM). The curve at RP 5.1 has a radius of 114.6 feet and 8% superelevation, which corresponds to a design speed of 24± mph (based on Equation 9.2-1 of the RDM: $V = [15R(e+f)]^{1/2} = [15*114.6(.08+.25)]^{1/2} = 23.8$ mph). Each of these two curves has warning signs with flashers and 20 MPH advisory speed plates.

The maximum grade is -4.522% at as-built station 483+00 (RP 9.25±), compared to the maximum grade of 5% for a rural collector in level terrain. All the crest vertical curves meet 60 mph design speed criteria. The three sag vertical curves that do not provide 60 mph design speed stopping sight distance (SSD) are summarized below:

PI Station	(MP)	Length (ft)	SSD (ft) (570' min.)	Design Speed
320+97	(6.14)	400	462	53 mph
456+00	(8.70)	400	442	56 mph
486+80	(9.28)	400	317	41 mph

B. Traffic Data

The traffic data listed below is for S-203 from RP 4.0 to RP 10.0

2014 ADT	=	3,500
2017 ADT	=	3,850
2037 ADT	=	7,320 (Design Year)
DHV	=	780
T	=	4.3%
ESAL's	=	116
Growth Rate (Annual)	=	3.3%

According to the ArcGIS MDT Traffic Data Map, the 2017 AADT along S-203 was 1,893 between RP1.25 and Dry Gulch Road RP 7.2±), and 5,090 along the segment of S-203 between Dry Gulch Road and the Highway 93 junction.

C. Crash Analysis

Safety Management completed a crash analysis for the segment from RP 4.0 to RP 10.1 covering the 3-year period from January 1, 2011 through December 31, 2013. The analysis evaluated the project from both a corridor-wide perspective as well from a segmentation perspective.

There were forty-one crashes reported, including thirteen injury crashes and one fatal crash. Thirty-six of the forty-one crashes were non-intersection related. In general, this portion of S-203 is performing at a Level of Safety Service (LOSS) III. This LOSS boundary indicates a moderate to high potential of crash reduction. For severe (fatal and injury) crashes, the project is also performing at LOSS III. For road departure crashes, this portion of S-203 is performing at a LOSS III overall, and specifically for severe road departure crashes,

There was one fatal injury crash with one fatality, thirteen injury crashes, and twenty-seven property-damage-only (PDO) crashes. Eighteen crashes involved collisions with wild animals, and in nine other crashes the vehicle overturned.

There were five intersection related crashes during the study period. Two occurred at the intersection of El Capitan Loop, with one crash resulting in a non-incapacitating injury, and the other in property-damage-only. The other three intersection crashes were evenly distributed within the project limits with no specific concentrations observed.

Crash clusters between reference posts 4.2 to 5.3 were identified in 2004, 2010, and 2012/2013. In 2004, the Safety Engineering Section noted that there had been no new crashes on the curve at RP 4.5 since new flashers and signage had been installed under HSIP 203-1(13)4, UPN 6073 and recommended the junction at Ambrose Creek Road and Moiese Lane be reconstructed. These recommendations yielded a benefit cost ration of 0.51 with an estimated cost of $2,500,000. Installing additional flashers were also reviewed and yielded a benefit cost ratio of 9.46 with a cost of $15,900.

Reference Post 4.6 to 4.7 was identified as a crash cluster in 2010. The Safety Engineering Section noted the project history and had no further recommendations. In 2012/2013, RP 4.593 to 5.130 was identified as a crash cluster. The Safety Engineering Section had no recommendations at that time.

Crash clusters between reference posts 5.9 to 7.6 were identified in 1998, 1999, 2001, 2010, and 2013/2014. No addressable trends were observed when RP 6.2 to 7.5 was identified in 1998, RP 5.9 to 6.4 and RP 7.0 to 7.6 were identified in 1999, and RP 7.1 to 7.6 was identified in 2001. Reference Post 6.4 to 6.9 was identified as a crash cluster in 2013-2014. The Safety Engineering Section noted that crashes had been declining in the previous 10 years and had no additional recommendations at that time due to the project history.

The section from approximately RP 8.5 to 9.5 is consistently performing at a LOSS IV for total crashes, severe crashes, road departure crashes, and severe road departure crashes. This LOSS boundary indicates a moderate to high potential for crash reduction. Nine crashes occurred between these reference posts, including one fatal, two incapacitating injury, one non-incapacitating injury, and five PDO crashes.

Three of the collisions occurred due to animals in the roadway, two crashes occurred on the curve at RP 8.8, two were due to icy conditions, the driver fell asleep in one crash, and one involved sideswiping a parked vehicle's side mirror.

Installing centerline rumble strips should be considered as this location has had six off-road left crashes during the study period and has been identified as an area meeting the cost effectiveness thresholds for installation of this countermeasure.

"Wildlife Crossing" warning signs and supplemental "Next 5 Miles" plaques are recommended at RP 5.5 and RP 10 to address the identified wild animal crash pattern.

Reconstructing the roadway to current design standards, including additional shoulder, rumble strips, clear zones and recoverable slopes, should mitigate the remaining observed crashes.

As noted elsewhere, we do plan to reconstruct the road with wider shoulders, flatter inslopes, increased clear zone width, shoulder rumble strips and centerline rumble strips (where appropriate).

We do propose wildlife crossing structures within the segment where most of the animal-vehicle collisions occurred.

An updated crash listing for the period from 2014 thru 2017 was reviewed to determine if the crash trends previously identified were still intact.

Crash Type	2011 – 2013 Total	2011 – 2013 (per year)	2014 – 2017 Total	2014 – 2017 (per year)
Wild Animal	18	6.00	25	6.25
Roll Over	9	3.00	5	1.25
Fixed Object	7	2.33	9	2.25
Rear End	1	0.33	7	1.75
Right Angle	2	0.67	3	0.75
Sideswipe	2	0.67	2	0.5
Multi-vehicle	6	2.0	16	4.0
Total*	41	13.67	58	14.5

* Only the top seven most prevalent crash types are listed. Total does not match sum of crash types listed.

The rate of single-vehicle crashes (11.67/yr. in 2011-13 vs. 11.00/yr. in 2015-17) has remained consistent. The increased rate of multi-vehicle crashes (2.0/yr. in 2011-13 vs. 4.0/ yr. in 2015-17) suggests that the reduced shoulder width along much of the project so that a two-way-left-turn and dedicated left turn lanes can be provided is appropriate.

D. Design and Posted Speed

A 60-mph design speed is proposed, appropriate for a rural collector in level terrain. The posted speed limit throughout the project limits is 60 mph for cars. The day/night speed limit for trucks is 60 mph/55 mph.

E. Environmental factors

- Natural resources: The Lee Metcalf National Wildlife Refuge is located west of S-203 between the highway and the Bitterroot River. The refuge is directly adjacent to S-203 between RP 6.2± and 7.1±.

  Seventeen wetlands have been delineated along the project between Sta.253+52± and Sta. 424+20± (RP 4.85± and RP 8.26±). All the wetlands are adjacent to natural drainages or irrigation ditches that either cross under the highway or parallel it. Preliminary design indicates all but one wetland will be impacted by roadway widening. Efforts to avoid/reduce impact to a given wetland by shifting the alignment was generally found to be futile because there would be increased impact to the wetland on the opposite side. There are a few sites where steepened fill slopes could provide a slight decrease in impact.

  There is one perennial stream crossing (Threemile Creek at RP 5.44). There are several other ephemeral drainage crossings; about four drain a large enough area to require a larger than the minimum 24" cross drain.

  The adjacent land use varies, and includes cultivated/irrigated agricultural land, rangeland, small to medium-sized residential lots, and some forested hillsides.

  Since inception of this project, discussion of habitat connectivity, wildlife crossing structures and wildlife fence has taken place among Montana Department of Transportation, Montanan Fish, Wildlife & Parks, Lee Metcalf Wildlife Refuge, Montana land reliance, Mule Deer Foundation, and the public.

  The project is approximately two-miles east of the wildlife corridor perpetuated in the 2005 highway reconstruction through the Bass Creek area along US 93 South. The crossings constructed on US 93 South serve to connect the Selway-Bitterroot Wilderness in the west to the Lee Metcalf Wildlife Refuge that lies across the Bitterroot River to the east.

  The Threemile Creek drainage extends east from the refuge toward Welcome Creek Wilderness in the Sapphire Mountains. National Forest, Threemile Wildlife Management Area, and several large conservation easements are additional open lands that significantly contribute to the connection of quality habitat across the project landscape.

  The most common recorded crash throughout the project was a collision with a wild animal, usually at night, dusk, or dawn.

- Cultural resources: There are four features along the project which have been recommended eligible for placement on the National Register of Historic Places.

  Sta. 220+70± to 222+90± LT (RP 4.2±): The front of this residential structure is about 73 feet from the PTW centerline.

  Station 289+46± to 291+11 RT± (RP 5.6±): This property is on the northeast corner of the Eastside Highway and Three Mile Creek Road. The front of the residential structure is about 70 feet from the proposed centerline, which

nominally matches the PTW along this constricted segment with residences close to the highway on both sides.

Station 312+21± to 314+31± RT: The front of this residential structure is about 51 feet from the proposed centerline, which virtually matches PTW. The proposed profile nearly matches the PTW through this area to reduce the extent of ditch excavation along the right side.

To avoid impact to the property, we will evaluate a shallow (6") v-ditch just beyond the toe of the surfacing inslope. A trench drain below the v-ditch would extend from the approach pipe south of the property to the approach pipe north of it. This design should avoid permanent impact to the property, although a construction permit and a right-of-way design exception would be needed.

Station 470+22 RT±: A Ponderosa Pine tree that has been culturally modified ("scar tree") is located about 56 feet east of PTW centerline, about 15 feet beyond the toe of the existing 13-ft. high embankment. A slight centerline shift to the west and a lowered grade will allow avoidance of the scar tree. However, a non-standard fill slope (2:1 or slightly flatter) shielded by guardrail will be required instead of a standard 6:1 fill to maintain an acceptable distance (8 feet) from the toe of embankment to the tree.

Description of Design Exception and Applicable Criteria

A. Standards for each controlling element

Horizontal alignment elements

- Minimum radii: 1,200'

Minimum lane and shoulder width

- The minimum width for a two-way-left-turn-lane (TWLTL) in rural areas is 14 feet.
- The minimum shoulder width is 8 feet, given the current ADT (> 3000) and the DHV (> 400). The Route Segment Plan map also indicates an 8-ft. shoulder is recommended for the entire length of S-203.

Side slopes

- Fill slopes: 0' to 10' - 6:1
  10' to 20' - 4:1
  20' to 30' - 3:1
  >30' - 2:1

  Cut backslopes: 0' to 5' - 5:1
  5' to 10' - 4:1
  10' to 15' - 3:1
  15' to 20' - 2:1
  > 20' - 1½:1

- Ditch section: 6:1 inslope 10 'wide with 20:1 bottom 10' wide

- Roadside clear zones:
  - 6:1 fill slope: 30'
  - 4:1 fill slope: 44'

B. Controlling element standards deviation

- Horizontal alignment: The minimum radius is 1,200 feet. We propose spiral curves with lesser radii at the following locations (RP refers to Reference Post):

  RP 4.60: 590 feet
  RP 5.05: 625 feet
  RP 5.19: 625 feet

  The proposed curves will balance the goal to improve safety on the route while limiting impacts to private property. The flatter curves will allow speeds closer to the average running speeds along the route

- Lane width: We propose a TWLTL width of 12 feet, compared to the14-ft. standard for rural routes. This deviation from standard supports the overall goal of the project to provide a safer road that addresses the crash trends and operational deficiencies at a reasonable construction cost, while minimizing impacts to road side properties where appropriate.

- Shoulder width: We propose a shoulder width of 4 feet along the segments where TWLTLs or dedicated left turn lanes are proposed. This deviation also supports the overall goal of the project to provide a safer road that addresses the crash trends and operational deficiencies at a reasonable construction cost, while minimizing impacts to road side properties where appropriate.

- Side slopes: We will strive to provide standard slopes, but we expect the following exceptions will be required along relatively short, intermittent locations:

Fill slopes:	Cut backslopes:
0' to 10' - 3:1 and flatter	0' to 5' – 3:1 or 4:1
10' to 20' - 1½:1 and flatter	5' to 10' – 2:1 or 3:1
20' to 30' - 1½:1 and flatter	10' to 20' – 2:1 and steeper
>30' - 1½:1 and flatter	> 20' - ½:1 and steeper

- Ditch section: We propose to reduce the flat-bottom ditch width to 0 feet (i.e. a v-ditch with a 6:1 inslope). Along several constrained segments where the proposed backslope is steeper than 4:1, the result will be a non-preferred ditch section that does not provide adequate roadside recovery width.

- Clear Zone – from EDL (no correction required for outside of curve)

Fill slope	Standard	Proposed (Unusual Circumstances Preclude Std.)
6:1	30'	≥ 24'
4:1	44'	≥ 19'

V-Ditch Section	Standard	Proposed (UCPS)
6:1/ 4:1	30'	≥ 25'

Collectively, these deviations from standard roadside design elements supports the overall goal of the project to provide a safer road that addresses the crash trends and operational deficiencies at a reasonable construction cost, while minimizing impacts to road side properties where appropriate.

C. Design exception details

- Horizontal alignment elements:

  We propose to replace the 210-ft. radius simple curve right (V = 30 mph) at RP 4.6 with a 590-ft radius spiraled curve (s= 8%, V = 45 mph).

  We propose to replace the 114.6-ft. radius simple curve left (V = 24 mph) with a pair of 625-ft radius spiraled curves (s= 8%, V = 45 mph) connected by a 56-ft. tangent superelevated at 2% at the Ambrose Creek Road intersection

- Auxiliary lane width: We propose a TWLTL width of 12 feet to reduce the impacts of the proposed total paved width, which at 44 feet will be 10 feet wider per side than the existing paved width.

- Shoulder width: We propose a shoulder width of 4 feet along the segments where TWLTLs or dedicated left turn lanes are proposed. This includes the segments from RP 4.08 to 6.12, RP 7.11 to 9.13, and RP 9.93 to 10.15. The 4-ft. shoulder will be a substantial improvement over the existing roadway, which has no shoulders.

- Fill slopes: We generally propose to use steeper recoverable slopes (i.e. 4:1's) along areas where a standard 6:1 slope would require more than 30 feet of new right-of-way acquisition. There will probably also be a few intermittent segments (including the historic properties, the wildlife refuge, and properties where improvements such as structures and drain fields would be impacted) where we will propose to steepen fill slopes less than 10 feet high to a 3:1.

  For fills 10 to 20 feet high where the standard 4:1 slope would require more than 40 feet of new right-of-way acquisition, we propose a 3:1 slope. Again, there could be a few isolated segments where we will propose a 2:1 or flatter slopes to avoid impacting roadside improvements.

  We'll strive to provide recoverable (i.e. 4:1 or flatter) fill slopes for fills up to 20 feet high. We'll also strive to provide a recoverable ditch section (i.e. 6:1

inslopes with 4:1 backslopes) for cuts up to 5 feet high. However, given the proximity of roadside improvements (houses, outbuildings, drain fields, etc.), we fully expect that construction limits will have to be "pulled in" to acquire many parcels.

- Flat-bottom ditch width: We propose to reduce the flat-bottom ditch width to as little as 0 feet (i.e. a v-ditch) where doing so will reduce the right-of-way acquisition required. With a 6:1/4:1 v-ditch, the lateral extent of construction impact will be reduced by about 7 feet on a 10-ft. cut, compared to the standard flat-bottom ditch with a 4:1 backslope.

D. Proposed design criteria and degree of reduction

- Horizontal alignment elements:

  We propose to replace the 210-ft. radius simple curve right (V = 30 mph) at RP 4.6 with a 590-ft radius spiraled curve (V = 45 mph). The proposed curve will balance the goal to improve safety on the route while limiting impacts to private property. Still, this alignment shifts the centerline about 162 feet southeast of the existing road. It will require complete acquisition of one parcel (with a dwelling) and about 25% of another parcel. Running speeds on the curve will more closely approach the overall running speeds of the route, especially compared to the existing condition, which requires drivers to slow to about 25 mph to negotiate the curve.

  We propose to replace the 114.6-ft. radius simple curve left (V = 24 mph) at RP 5.1 with a pair of 625-ft radius spiraled curves (s= 8%, V = 45 mph) connected by a 56-ft. tangent superelevated at 2% at the Ambrose Creek Road intersection. This alignment deviates up to 305 feet northwest of the current alignment. The 2% super elevation on the short tangent will enhance turning maneuvers for towing vehicles at this high-volume junction. Again, running speeds on the curve will more closely approach the overall running speeds of the route, especially compared to the existing condition, which requires drivers to slow to about 25 mph to negotiate each of the curves.

  The three curves described above are the preferred action to replace the two extremely substandard curves because they will allow operating speeds through the curves much closer to the mainline running speeds, yet will have much less impact to the adjacent agricultural and residential properties, compared to the impact of two new curves that meet the standard for minimum radius (see Exhibit A)

- Auxiliary lane width

  The proposed 12-ft. two-way-left-turn lane (TWLTL) is two feet, or 14.3% narrower than the standard 14-ft. width. The TWLTL is proposed along eight sections totaling 1.5 miles, the longest of which is 0.5 miles long. (Segments striped as a dedicated left turn lane are not included in the total).

- Shoulder width:

  The proposed shoulder width of 4 feet along the segments where TWLTLs or dedicated left turn lanes will exist is 50% narrower than the standard 8-ft. width. There is a total of 7.96 lane-miles with the 4-ft shoulder, or 67.5% of the total of 11.79 lane miles. In each direction there are four segments with 4-ft. shoulders that range from 0.28 to 2.76 miles long.

- Fill slopes: The extent of proposed fill slopes that do not meet standards for a given fill height are tabulated below. The proposed 4:1 slope will provide the recommended 44 feet of clear zone on about 78% of the road, while the other 22% will provide at least 38 feet of clear zone.

4:1 fill slope proposed vs. std. 6:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
279+25 to 280+25	100	100	200
281+50 to 281+75	125	125	250
322+50 to 335+50	1,300		1,300
323+00 to 324+00	-	100	100
353+75 to 360+00	625 (min 38' cz)		625
378+50 to 379+50	100 (min.42' cz)		100
414+75 to 415+75	-	100	100
422+75 to 423+25	-	100	100
452+25 to 452+75	50 (min 40' cz)		50
454+ 75 to 455+75	100 (min 40' cz)		100
456+75 to 459+25	250		250
471+25 to 473+75	250		250
484+25 to 485+25	100		100
489+25 to 491+75	250		250
505+25 to 506+75	150		150
TOTAL	3,400	525	3,925

The 3:1 fills along the short segment listed below will transition in to and out of the 2:1 fills at the Three Mile Creek crossing.

3:1 fil slope proposed vs. std 6:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
280+25 to 280+50	25	25	50
281+25 to 281+50	25	25	50
TOTAL	50	50	100

The 2:1 fills listed below at Station 281± are intended to limit the length of the 14'-2" span x 9'-10" rise SSPPA at the Three Mile Creek crossing. At Station 432± Left and again at Station 481± Left, the 6:1 inslope of the lowered roadway will daylight on the existing 2:1 embankment. The 2:1 slope at Station 470± Right will avoid impact to the culturally sensitive Scar Tree.

2:1 fill slope proposed vs. std 6:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
280+50 to 281+25	75	75	150
431+75 to 433+25	150	-	150
469+75 to 471+25	-	150	150
480+75 to 481+25	50	-	50
TOTAL	275	225	500

The 2:1 slopes listed below will minimize impact to a natural intermittent drainage at each location that crosses the highway at the base of a 20-ft. embankment.

2:1 fill slope proposed vs. std 4:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
413+25 to 414+75	150	-	150
422+25 to 423+25	100	-	100
460+25 to 460+75	50	50	100
TOTAL	300	50	350

The proposed 3:1 (vs.4:1) and 2:1 (vs. 3:1) fill slopes shown below will avoid impact to a parcel identified years ago as contentious.

3:1 fill slope proposed vs. std 4:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
470+25 to 470+75	50	-	50
2:1 fill slope proposed vs. std 3:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
470+75 to 471+25	50	-	50

The proposed 2:1 (vs. 3:1) fill slopes shown below will avoid impact to concrete structures used in fire-fighting training by the Three Mile Fire Department.

2:1 fill slope proposed vs. std 3:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
406+50 to 408+75	225	-	225

At the locations listed below, the 6:1 inslope of the lowered roadway will daylight on the existing 1½:1 embankments that are 20 to 70+ feet high.

1½:1 fill slope proposed vs. std 3:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
422+25 to 423+25	100	-	100

1½:1 fill slope proposed vs. std 2:1			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
434+00 to 438+25	425	-	425

- Ditch section: The extent of proposed 6:1/4:1 v-ditch is tabulated below. Most of these segments will provide the required 30 feet of clear zone either within the backslope or on the level area just beyond the top of backslope. The minimum width of recovery area provided (25 feet at top of backslope) will occur on about 8 percent of the entire extent of 6:1/4:1 v-ditch.

6:1/4:1 v-ditch vs. std. flat-bottom ditch			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
210+50 to 234+00	2,350	2,350	4,700
234+00 to 246+00		1,200	1,200
246+25 to 249+25	300		300
249+25 to 258+75	950	950	1,900
258+75 to 264+25	550	-	550
264+25 to 275+75	1,150	1,150	2,300
275+75 to 278+75		300	300
283+25 to 287+75		450	450
284+25 to 286+50	225	-	225
288+25 to 295+75	-	750	750
288+75 to 289+25	50	-	50
295+25 to 295+75	50	-	50
298+50 to 302+25	-	375	375
307+75 to 318+00	-	1,025	1,025
312+75 to 317+25	450	-	450
335+50 to 341+75	625	-	625
345+00 to 377+75	-	3,275	3,275
345+25 to 348+75	350	-	350
368+00 to 371+75	375	-	375
378+25 to 383+00	-	475	475
385+75 to 393+00	-	725	725
386+75 to 390+25	350	-	350
391+ 25 to 392+00	75	-	75
397+75 to 399+50	175	-	175

402+25 to 403+75	-	150	150
409+25 to 412+75	350	-	350
415+75 to 422+25	-	650	650
418+25 to 422+25	400	-	400
423+25 to 431+50	825	-	825
423+75 to 430+75	-	700	700
433+25 to 434+00	75	-	75
442+00 to 445+00	-	300	300
442+25 to 454+25	1,200	-	1,200
455+25 to 456+75	-	150	150
460+75 to 461+25	-	50	50
461+25 to 468+50	725	-	725
463+75 to 469+75	-	600	600
473+25 to 474+25	-	100	100
474+50 to 478+75	425	-	425
479+75 to 480+25	50	-	50
481+50 to 482+00	-	50	50
482+25 to 483+25	100	-	100
488+25 to 494+25	-	600	600
495+25 to 502+75	750	-	750
499+25 to 505+25	-	600	600
506+25 to 517+00	-	1,075	1,075
513+75 to 521+00	725	-	725
TOTAL	13,650	18,050	31,700

The following v-ditch sections will have a 6:1 inslope and a backslope 3:1 or steeper. The inslope will provide about 24 feet of recoverable slope between the edge of driving lane and the ditch bottom. The steeper backslopes are proposed along areas where a standard backslope would nominally require more than 40 feet of right-of-way acquisition.

V-ditch (6:1 inslope with backslope 3:1 or steeper)			
STATION	DIST. (FT. - LEFT)	DIST. (FT. - RIGHT)	TOTAL (FT)
426+50 to 430+75	-	425	425
453+75 to 455+25	-	150	150
TOTAL	-	-	575

The proposed fill slopes and v-ditches will provide a much safer roadside compared to existing conditions, while keeping impacts to roadside properties reasonable, which is consistent with the purpose and need. The v-ditches will be reviewed by Hydraulics. There may be a few short intermittent sections where a flat-bottom ditch is recommended to provide adequate capacity.

E. Graphical representation (attached)

Exhibit A: RP 4.4 to RP 5.5 - Standard curve radii vs. proposed curve radii

Exhibit B: Typical Section elements - Standard vs. proposed

Exhibit C: Representative cross sections – Standard vs. proposed

Impacts

A. Analysis of impact on corridor operations

In 2009, the Traffic & Safety Bureau analyzed the Level of Service (LOS) provided by a roadway with shoulder widths of 0, 2, 4, 6, and 8 feet for traffic volumes projected out to 2033. Because standard 12-ft. travel lanes are proposed, it was determined that shoulder width has no impact on the LOS.

During the Roadway Width Decision process in 2009, the review team recommended a combined through lane/shoulder width of 40 feet (two 12-ft. lanes and two 8-ft. shoulders) for the subject project and the adjoining project to the north (Florence – East).

However, the Traffic Engineer reviewed the traffic characteristics and roadside development of the subject project and Florence – East from a corridor perspective. She recommended a 44-ft. top width (two 12-ft lanes, two 4-ft. shoulders, and a 12' striped median, marked for a left turn lane where appropriate). It was suggested that a 40-ft. top that was widened for turn lanes only at a few select public approaches could be perceived as short-sighted by the traveling public.

It was also noted that the route has been designated a bike route, and that it would be desirable to provide 6-ft. shoulders. The team agreed that wider shoulders would be desirable, but available construction funding indicated we can't afford all the desired features.

The team determined a 44-ft. top was appropriate for both projects. A 48-ft. top (with 6-ft. shoulders) would likely require more right-of-way. There were/are concerns that greater right-of-way impacts could delay the project interminably.

During the public involvement process for [6138000], it was requested we provide some passing opportunities because during the off-peak hours, there are gaps in oncoming traffic such that slow-moving vehicles could be safely passed. The need to provide access (three lanes) versus mobility (two lanes with passing opportunities where sight distance is available) was again evaluated using engineering judgement, the public input and discussion with MDT and Ravalli County officials. The following items were evaluated:

- Access density.
- Updated left turn involved crashes.
- Updated roadside development and planned future development

After consideration of the preceding factors, the recommendation was refined to provide two segments (RP 6.13 to 7.12 and RP 9,13 to 9.88) where the TWLTL would be dropped in favor of a two-lane configuration with 10-ft shoulders that would be striped for passing where adequate sight distance exists.

B. Analysis of impact on corridor safety

- *The Highway Safety Manual* (HSM) procedures were used to compare the expected crashes for the current (PTW) facility to the expected crashes for the proposed design with shoulder widths of 4, 6, and 8 feet.

Expected Crash Reduction (%) compared to PTW conditions			
Shoulder width	Fatal & Injury crashes	Property Damage Only crashes	Total Crashes
4	36.0	34.9	34.9
6	38.2	37.2	37.2
8	39.9	38.9	38.9

The cumulative impact of the various proposed design elements results in a substantial expected crash rate reduction. The effect of shoulder width alone is more incremental.

C. Adjacent roadway sections and future work plans

The four-mile section of Secondary 203 to the south is similar in character to the existing conditions found on [6138000]. It has virtually no shoulders and narrow, steep ditches. The terrain is generally level, with only gentle variations in profile grade. The horizontal alignment is mostly on tangent, except for one 90° curve about 2.7 miles south of the beginning of [6138000].

There are currently no anticipated improvements beyond routine pavement preservation. One could speculate that any future reconstruction projects would be designed to be compatible with [6138000].

The 2.1-mile section of S-203 to the north was reconstructed in 2015 under **BR-STPS 203 1-(11)10 Florence – East [4854]**. That project predominantly features 4-ft. shoulders and a 12-ft. TWLTL. Design exceptions were approved for non-standard ditch sections and fill slopes along intermittent segments throughout the project. The one non-standard horizontal curve was replaced with a three-legged roundabout about 0.3 mile north of the end of [6138000].

The proposed improvements under [6138000] are compatible with those already constructed on the segment to the north.

D. Review of impact to driver expectation

The majority of those traveling Secondary 203 are residents who use it on a daily basis. The proposed horizontal alignment, shoulder widths, and TWLTL width have been communicated to the public during public meetings, personal contacts, and via the project website. The requested design exceptions will have little impact on driver expectations.

E. Design Speed Exception

Not applicable

Alternatives Considered

One alternative alignment to replace the two substandard horizontal curves is shown in Exhibit A. We do not believe we could justify the substantial impacts to at least nine parcels. Several other parcels could also be severely impacted to provide access to the new alignment. The selected alignment strikes a good balance in our need to substantially improve the safety and operation through this section with our desire to not severely impact several roadside properties. There are segments along the project where a standard 8-ft. shoulder and/or 14-ft. TWLTL could be constructed with little additional impact to roadside properties. However, to maintain consistency and not violate driver expectancy we rejected this notion.

We considered a three-legged roundabout at RP 5.1, where Ambrose Creek Road and Moiese Lane intersect S-203 at the existing 115-ft. radius curve. The concept was dropped due to cost and strong opposition by an adjacent landowner.

The proposed "broken back" curve at the intersection will be a substantial improvement over the existing situation and will better accommodate the towing vehicles that frequently turn on to and off of S-203 at this intersection.

Mitigation Measures

We propose to increase the shoulder width to 8 feet on the outside of each of the 45-mph curves proposed at RP 4.6 and RP 5.1. Due to the substantial alignment shifts, no additional right-of-way will be needed for an 8-ft. shoulder compared to a 4-ft. shoulder at these locations. Curve warning signs with appropriate speed plates will also be installed.

Intersection-related crashes will be mitigated by the inclusion of a TWLTL or dedicated left turn lanes along much of the project. The reduced shoulder width is an appropriate tradeoff along these segments to keep overall impacts reasonable.

Guardrail will be installed where warranted because the topography precludes providing a traversable roadside. The most notable locations include the Threemile Creek crossing at RP 5.44, several other large drainage crossings, and sections with steep fill slopes (RP 7.9 to 8.1, RP 8.2 to 8.3, and RP 8.4 to 8.6).

Shoulder rumble strips will be installed throughout the project. We also propose centerline rumble strips along the two segments that will be striped for two lanes with 10-ft shoulders.

The tree clearing associated with reconstructing the slopes will increase sight lines for motorists, giving them more time to react appropriately to wildlife on the roadside.

Several drainage structures will be upsized to better accommodate wildlife crossings.

Anticipated Costs

The B/C Analysis Shoulder Width spreadsheet (developed by the Traffic Safety Section) was used to complete a benefit-cost analysis for each of three shoulder widths (4', 6', and 8'). The benefits were based on the annualized predicted crash reduction savings using the non-junction crash data from 2014 through 2017, which included one fatal crash, six incapacitating injury crashes, four non-incapacitating injury crashes, two possible injuries, and 32 property-damage-only crashes.

The construction cost estimates (CN+CE+IDC) and maintenance costs were annualized over 20 years to determine the cost element of the ratio.

BENEFIT/COST COMPARISON			
SHOULDER WIDTH	4 -FT	6 -FT	8 -FT
CONST. COST (CN+CE+IDC)	$10,479,900	-$10,691,200	$11,106,700
EQUIV, UNIFORM ANNUAL BENEFIT	$1,210,097	$1,512,621	$1,774,809
EQUIV, UNIFORM ANNUAL COST	$680,122	$693,955	$721,010
BENEFIT/COST RATIO	1.78	2.18	2.46

It is difficult to accurately estimate right-of-way acquisition and utility relocation costs at this stage, but we believe that those costs could be substantially higher for the 8-ft. shoulder, since it would require a wider footprint than either the 4-ft. or 6-ft. option. Thus, the B/C for the 8-ft. shoulder would be reduced compared to those for the 4-ft. or 6-ft. shoulder if those costs are considered in the calculation.

Recommendation/Summary

The three horizontal curves proposed, each of which has a radius less than the minimum for a 60-mph design speed, are nonetheless substantial improvements over the existing curves, with much less impact to adjacent properties compared to standard curves. The improved intersection operations at these curves and cost-effective mitigation measures should offset the non-conforming elements.

The proposed 4-ft. shoulders and 12-ft. TWLTL will provide substantial hazard reduction compared to existing conditions, whereas standard widths for these features are expected to provide only incremental additional crash reduction potential.

The proposed roadside slopes will be much more forgiving for errant vehicles that depart the roadway. Excluding slopes that warrant guardrail, over 98% of the roadside slopes that do not meet standards will still provide a recoverable clear zone.

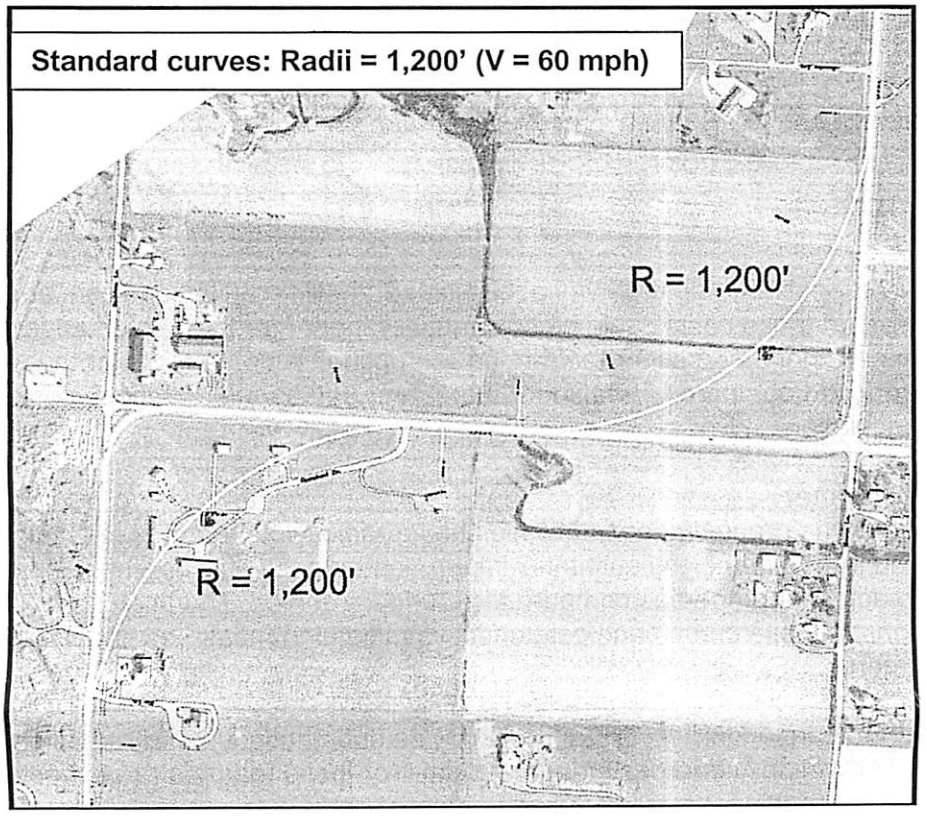
The additional construction cost, additional right-of-way acquisition required, as well as greater environmental impacts to upgrade the existing highway to full standards cannot be justified to provide the incrementally increased safety benefits. The proposed improvements will provide the desired outcome – a substantially safer facility that can be constructed at an affordable cost while keeping impacts to adjacent features and properties reasonable and equitable.

The design as proposed is consistent with MDT's goal to develop context-sensitive projects that balance cost, safety, mobility, social and environmental impacts, and the needs of a wide variety of roadway users. The requested design exceptions are justified.

Concur: _____ Date Dec. 20, 2018
Lesly Tribelhorn, PE
Highways Engineer

Choose a District.

Exhibit A (RP 4.4 to RP 5.5: Standard curves vs. proposed curves)



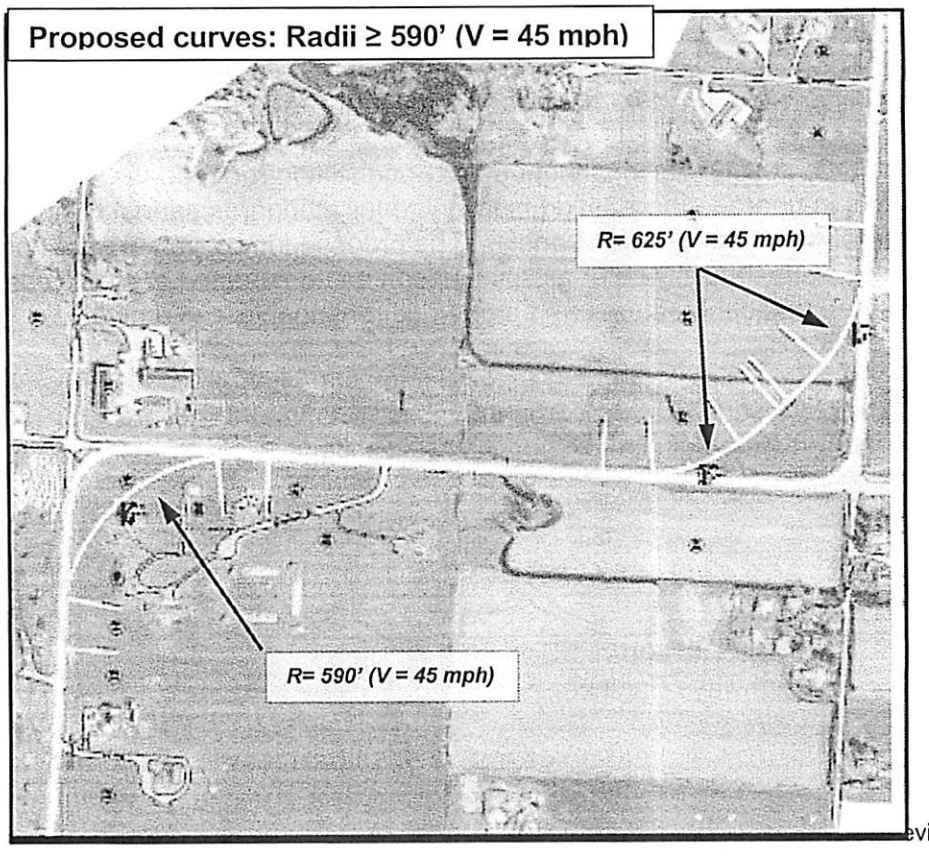
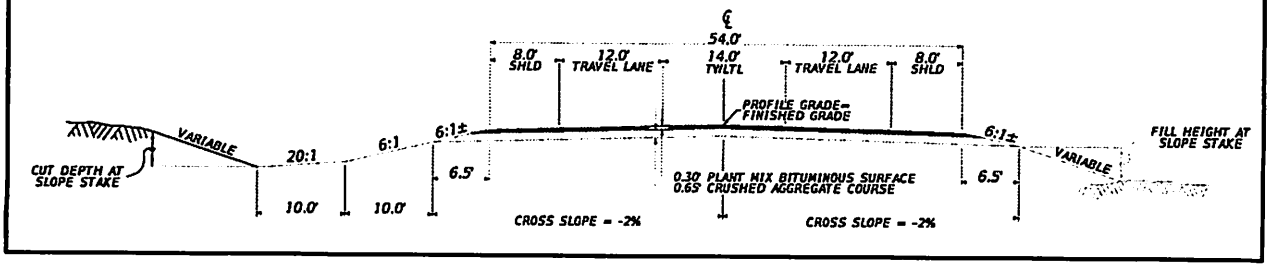


Exhibit B (Typical Section elements): Std.14' TWLTL vs. Proposed 12' TWLTL
Std. 8' shoulders vs. Proposed 4'shoulders
Std. flat-bottom ditch vs. Proposed v-ditch

Standard Typical Section
8' Shoulders
14' TWLTL
Flat-bottom ditch



Proposed Typical Section
4' Shoulders
12' TWLTL
V-ditch

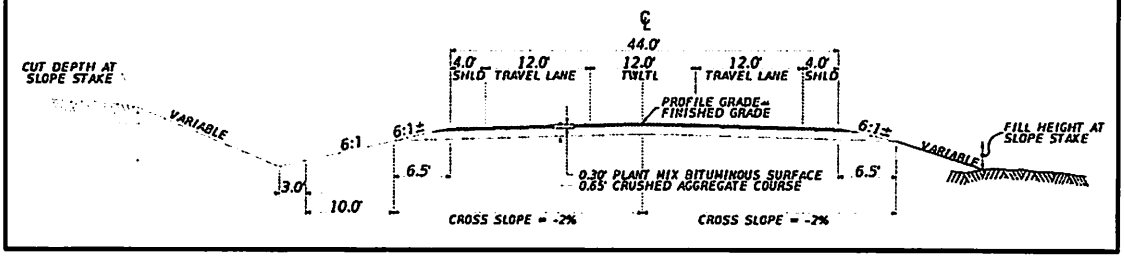
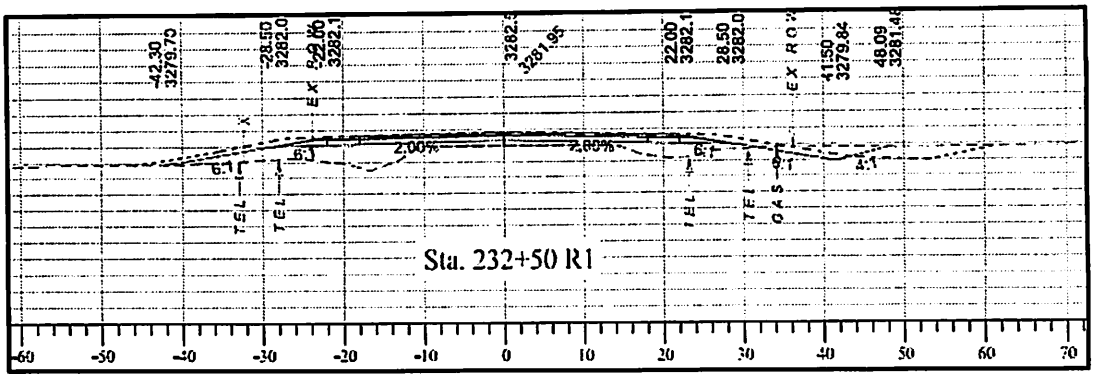
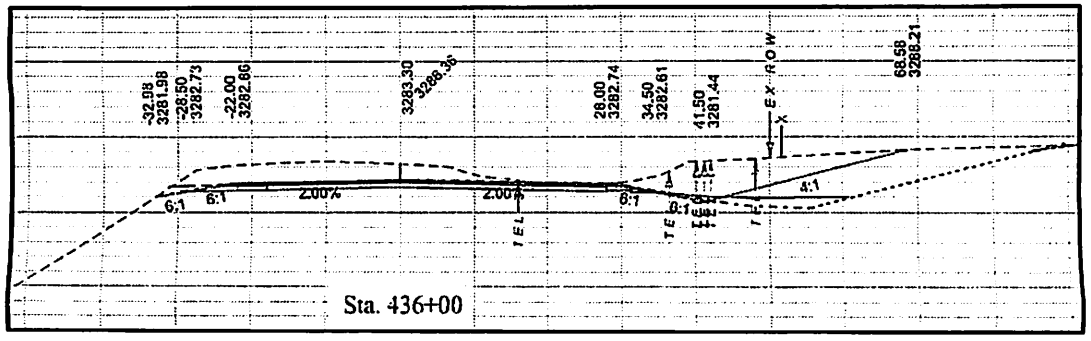
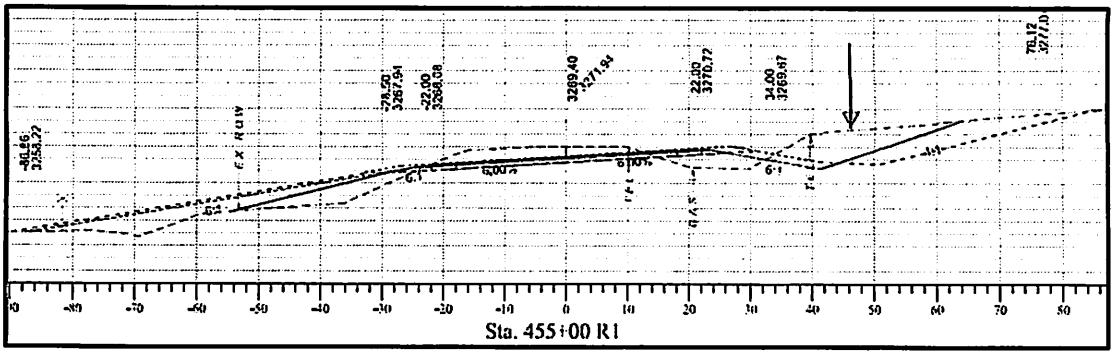
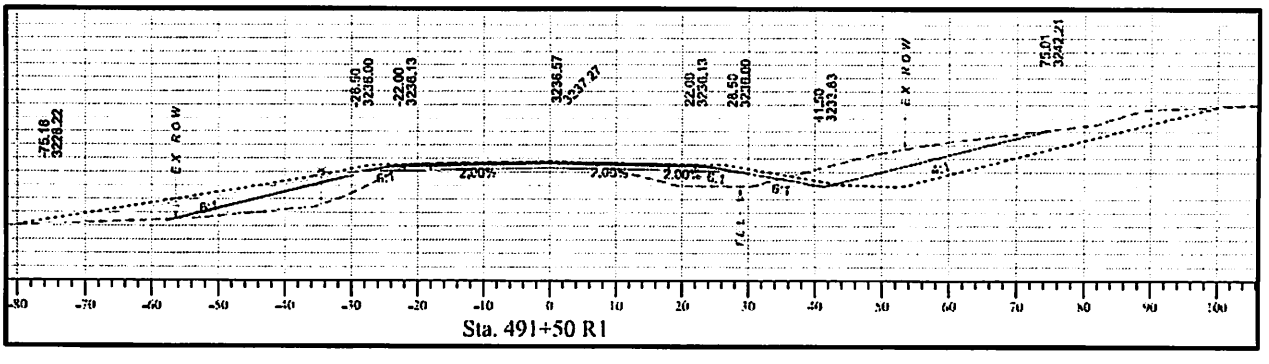


Exhibit C (Representative cross-sections)









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William M. Squires EPS Project Manager, Missoula District

Ravalli County Commissioners
215 S. 4th Street, Suite A
Hamilton, MT 59840

e-copies:

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