MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MONITORING REPORT

Little Rock Creek at Judith Slide Repair
Fergus County, Montana

Project Completed: 2013
Monitoring Report #2: December, 2015

Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared by:

CONFLUENCE

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MONITORING REPORT #2

YEAR 2015

Little Rock Creek at Judith Slide Repair
Fergus County, Montana

MDT Project Number: STPS 426-2(12) 15
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SPA# MDT-R4-55-2012
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Prepared for:

MONTANA DEPARTMENT OF TRANSPORTATION
2701 Prospect Ave
Helena, MT 59620-1001

Prepared by:

Confluence Consulting, Inc.
P.O. Box 1133
Bozeman, MT 59771

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Cover Photo: Little Rock Creek looking south (upstream) at the Judith Slide Repair site in 2015.

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APPENDICIES

1.0 INTRODUCTION

As part of an emergency roadway repair, the Montana Department of Transportation (MDT) realigned a segment of Secondary Highway 426 (also known as S-426 or Hanover Road), around a land slide to provide a stable, paved roadway through the area and reduce annual road maintenance requirements. Due to the new road alignment, modification to a segment of Little Rock Creek, a tributary to the Judith River, was also necessary. This channel modification was approved by the U.S. Army Corps of Engineers and does not require compensatory mitigation for stream impacts.

Although compensatory mitigation is not required, MDT requested monitoring of the reconstructed segments of Little Rock Creek to evaluate whether the stream restoration and revegetation techniques were successful in generating a stable, well vegetated channel with variable habitat elements. The following report provides the results of the second year of monitoring along this segment of Little Rock Creek. This project was constructed in 2013, therefore, these results provide documentation of the site's condition two years following the project's completion.

Specific project objectives outlined in the joint permit application for Little Rock Creek included:

- Removal of a 163" x 120" structural steel plate pipe and placement of a 12' x 12' reinforced concrete box culvert approximately 222 feet long to provide fish passage.
- Control spring seepage via interceptor trenches and slope armoring to route water into nearby ditches and culvert.
- Constructing 536 feet of new stream channel within the reclaimed segment of the former highway alignment.

Results of the second year of monitoring at the Judith Slide Repair site are provided in Section 4, while Section 5 provides additional site observations that were not captured by the monitoring protocols. Appendices to this monitoring report include maps indicating the endpoints of riparian belt transects, longitudinal profile and perpendicular transect surveys, vegetation communities, noxious weeds, and eroding banks; plots of perpendicular transect and longitudinal profile surveys; photo documentation of the project site; and a topographic survey of the project site (surveyed in 2014).

2.0 SITE LOCATION

The project site is located near Lewistown in the NE ¼ NE ¼ of Section 27, Township 16 North, Range 16 East, and the NW ¼ NW ¼ of Section 26, Township 16 North, Range 16 East, in Fergus County, Montana (Figure 1).

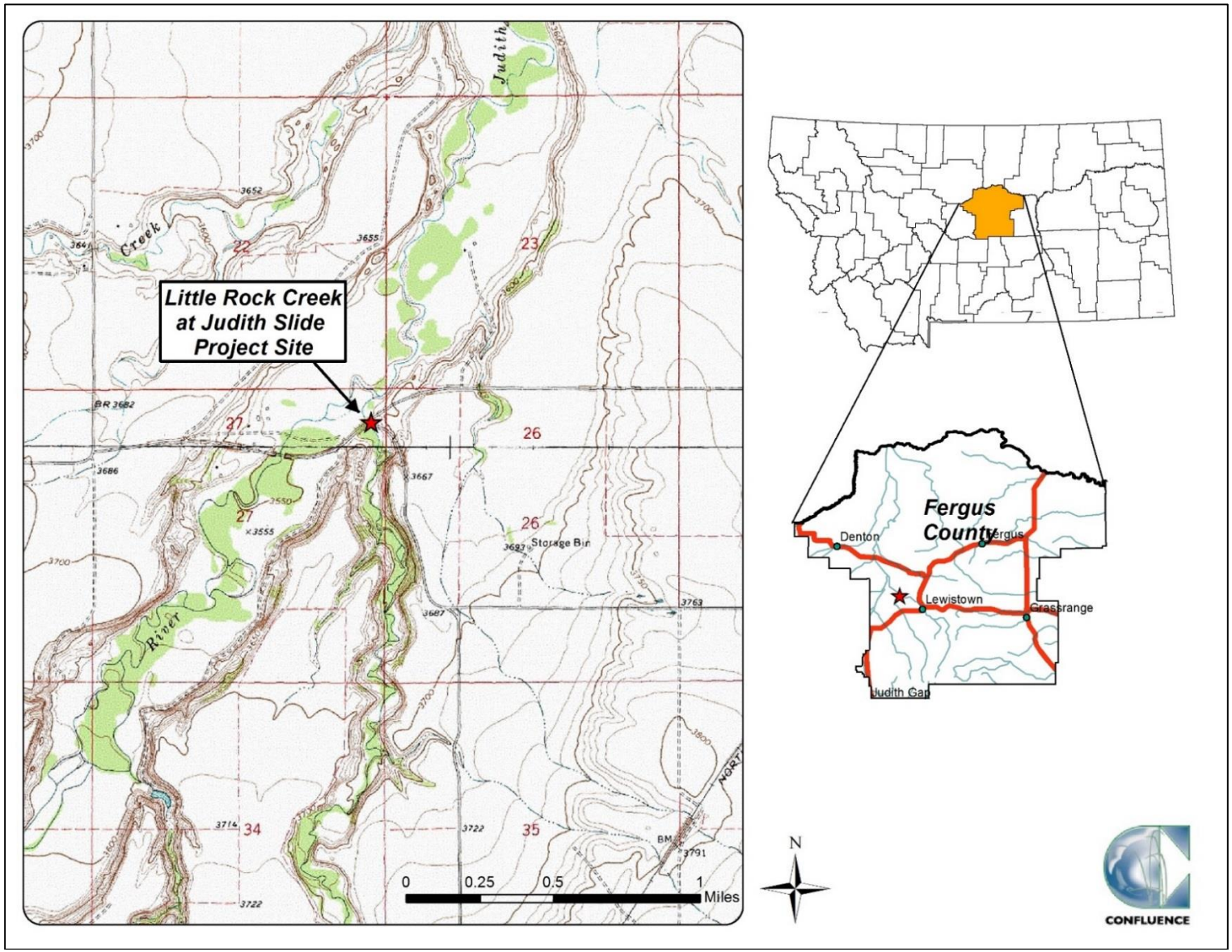

Figure 1. Project location of the Little Rock Creek at Judith Slide Repair site.

3.0 MONITORING METHODS

Monitoring and survey field crews visited the project site on July 30, 2015. The following data were collected at the Little Rock Creek at Judith Slide Repair site:

3.1. Vegetation Inventories and Community Mapping

Two riparian belt transects established in 2014 were monitored to document riparian vegetation development and community diversity, as well as areal percent cover of total vegetation, woody vegetation, and noxious weeds within 25 feet of the newly aligned stream channel. The riparian transect on the right (east) bank runs parallel to the channel for 203 feet, while the riparian transect on the left (west) bank extends 192 feet.

A vegetation inventory was conducted along both stream banks, which included compiling a list of all plant species and their associated cover classes identified within three feet of the active channel. Percent cover of all species observed along approximately 630 feet of each bank was estimated and recorded using the following classification values: 0 (less than 1 percent), 1 (1 to 5 percent), 2 (6 to 10 percent), 3 (11 to 20 percent), 4 (21 to 50 percent), and 5 (greater than 50 percent).

Vegetation community boundaries were determined in the field during the active growing season and subsequently delineated on the 2015 aerial photographs. Community types were named based on the predominant vegetation species that characterized each mapped polygon (Figure 3, Appendix A). Bank stability indices were assigned to the stream bank community types using Winward (2000) stability scores.

The project site was visually inspected to document the presence of noxious weeds. All noxious weed infestations were mapped on aerial photographs, with species and extents noted. Observations of isolated noxious weed occurrences were included in the species lists and total areal percent cover estimate of noxious weeds within the project area, but were not mapped.

3.2. Bank Erosion Inventory

Both stream banks within the project reach were visually inspected to document eroding banks. Each eroding bank within the project reach was photo-documented. Data collected at each eroding bank included bank length and potential causes of bank erosion.

3.3. Channel Surveys

Four perpendicular transects (cross sections) established in 2014 were re-surveyed; two at riffles and two at pools. A longitudinal profile of the channel thalweg was also re-surveyed to document bedform complexity and aquatic habitat conditions.

3.4. Photo-Documentation

Photos were taken at all photo points established in 2014 to document riparian and stream conditions throughout the project reach. Survey crews documented stream and

bank conditions by taking additional photos facing upstream, downstream, left and right from the center of the channel and at the endpoints of each of the four perpendicular transects.

3.5. Wildlife Documentation

Wildlife use of the project reach was documented by creating a list of all bird, mammal, and herpetile species observed during the site visit. Wildlife species were identified through visual observation, scat, tracks, and observation of nests, burrows, dens, feathers, etc.

4.0 RESULTS

4.1. Riparian and Stream Bank Vegetation Inventory

Table 1 summarizes the areal percent cover of total vegetation, woody vegetation, and noxious weeds observed along each riparian and stream bank transect during the 2014 and 2015 monitoring events. Total percent cover of vegetation increased from 58% in 2014 to 83% in 2015. Total percent woody cover increased from 7% in 2014 to 14% in 2015. Percent cover of noxious weeds increased from 0.2% in 2014 to 3% in 2015. These vegetation transects were both located downstream of the box culvert, and are representative of the reconstructed channel and associated riparian zones below the culvert outlet. Vegetation upstream of the culvert is establishing well with a diversity of stream bank and riparian vegetation developing on both sides of the channel (See Photo Point 1 and Additional Photo #11 in Appendix A).

Table 1. Percent cover of vegetation transects at the Judith Slide Repair site in 2015.

Belt Transect	Length (ft)	Total % Vegetation Cover		% Woody Cover		% Noxious Weed Cover	
		2014	2015	2014	2015	2014	2015
Right (east) Riparian	203	60%	80%	0%	0%	0%	4%
Left (west) Riparian	192	50%	80%	0%	0%	0%	4%
Riparian Subtotal		55%	80%	0%	0%	0%	4%
Right (east) Stream bank	630	65%	90%	47%	50%	1%	2%
Left (west) Stream bank	630	65%	90%	47%	50%	1%	2%
Streambank Subtotal		65%	90%	47%	50%	1%	2%
Area Weighted Total		**58%**	**83%**	**7%**	**14%**	**0.2%**	**3%**

Table 2 includes a comprehensive list of plant species observed during the 2014 and 2015 monitoring events. In 2015, 69 plant species were identified as compared to 52 species observed in 2014. Approximately one-third of the new species observed were present along the stream banks, while two-thirds of the new species were found within the riparian areas adjacent to the channel. Of the 69 plants observed, 29 (42%) were considered hydrophytic based on the 2014 National Wetland Plant List (NWPL) (Lichvar *et al*., 2014). The vegetation observed within the riparian and stream bank corridor comprised a mix of native and nonnative annual, biennial, and perennial plant species.

The species composition will likely change over time as the site stabilizes and recovers from its recent disturbance in 2013.

Table 2. Comprehensive list of plant species observed at the Judith Slide Repair site in 2014 and 2015.

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
Agastache urticifolia	Nettle-Leaf Giant-Hyssop	FACU
Agrostis stolonifera	**Spreading Bent**	**FAC**
Algae, green	Algae, green	NL
Arctium minus	**Lesser Burrdock**	**UPL**
Artemisia absinthium	**Absinthium**	**NL**
Bromus inermis	**Smooth Brome**	**FAC**
Bromus japonicus	Japanese Brome	NL
Calamagrostis canadensis	Reed Grass	FACW
Carduus nutans	Nodding Plumeless-Thistle	UPL
Carex sp.	Sedge	NL
Chenopodium album	Lamb's-Quarters	FACU
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	**Bull Thistle**	**FACU**
Cynoglossum officinale	Gypsy-Flower	FACU
Descurainia sophia	Herb Sophia	NL
Elymus canadensis	**Nodding Wild Rye**	**FAC**
Elymus hispidus	Intermediate Wheatgrass	NL
Elymus repens	Creeping Wild Rye	FAC
Epilobium ciliatum	Fringed Willowherb	FACW
Euphorbia esula	Leafy Spurge	NL
Glyceria grandis	**American Manna Grass**	**OBL**
Glyceria striata	Fowl Manna Grass	OBL
Helianthus annuus	Common Sunflower	FACU
Hordeum jubatum	Fox-Tail Barley	FAC
***Juncus* sp.**	**Rush**	**NL**
Kochia scoparia	Mexican Kochia	NL
Lactuca serriola	Prickly Lettuce	FACU
*Lepidium campestre***	Field Pepper-Grass**	NL
Matricaria discoidea	Pineapple-Weed	FACU
Medicago lupulina	Black Medick	FACU
Medicago sativa	Alfalfa	UPL
Melilotus albus	White Sweetclover	NL
Melilotus officinalis	Yellow Sweet-Clover	FACU

Scientific Name	Common Name	WMVC Indicator Status*
Mentha arvensis	American Wild Mint	FACW
Myriophyllum sp.	Water-Milfoil	NL
Nasturtium officinale	Watercress	OBL
Oenothera villosa	**Hairy Evening-Primrose**	**FAC**
Onopordum acanthium	Scotch Thistle	NL
Pascopyrum smithii	Western-Wheat Grass	FACU
Persicaria amphibia	Water Smartweed	OBL
Persicaria maculosa	Spotted Lady's-Thumb	FACW
Persicaria sp.	Smartweed	NL
Phalaris arundinacea	Reed Canary Grass	FACW
Phleum pratense	**Common Timothy**	**FAC**
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Polypogon monspeliensis	Annual Rabbit's-Foot Grass	FACW
Populus angustifolia	Narrow-Leaf Cottonwood	FACW
Prunus virginiana	Choke Cherry	FACU
***Ribes* sp.**	**Currant**	**NL**
Rosa woodsii	**Woods' Rose**	**FACU**
Rudbeckia laciniata	**Green-Head Coneflower**	**FAC**
Rumex acetosa	Garden Sorrel	FAC
Rumex crispus	Curly Dock	FAC
Rumex fueginus	Tierra del Fuego Dock	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Scirpus microcarpus	Red-Tinge Bulrush	OBL
Sinapis arvensis	Corn Mustard	NL
Sisymbrium altissimum	**Tall Hedge-Mustard**	**FACU**
Solidago canadensis	Canadian Goldenrod	FACU
Sonchus arvensis	Field Sow-Thistle	FACU
Symphoricarpos albus	Common Snowberry	FACU
Thlaspi arvense	Field Pennycress	UPL
Tragopogon dubius	**Meadow Goat's-Beard**	**NL**
Trifolium pratense	**Red Clover**	**FACU**
Urtica dioica	Stinging Nettle	FAC
Verbascum thapsus	**Great Mullein**	**UPL**
Veronica americana	American-Brooklime	OBL

* Based on 2014 NWPL (Lichvar *et al*., 2014)
***Lepidium latifolium* was misidentified in 2014 and has been changed to *Lepidium campestre*
New species identified in 2015 are **bolded**.

Dominant species recorded along the riparian and stream bank transects were combined with visual observations in other areas to develop a vegetation community map (Figure 3, Appendix A). The dominant plant species observed within the riparian zone were western-wheat grass (*Pascopyrum smithii)* and yellow sweet-clover (*Melilotus officinalis*), which occurred above the coir encapsulated soil lifts. The lower

banks of the channel were dominated by coyote willow (*Salix exigua*) and reed canary grass (*Phalaris arundinacea*).

Three vegetation community types were observed in 2015 (Figure 3, Appendix A) including:

Community Type 1: *Salix exigua* / *Phalaris arundinacea*
Community Type 5: *Elymus* spp. / *Melilotus officinalis*
Community Type 6: *Pascopyrum smithii* / *Melilotus officinalis*

Vegetation community Type 2 – *Elymus* spp. was identified in 2014 north and south of S-426/Hanover Road and was changed in 2015 to community Type 5 – *Elymus* spp./*Melilotus officinalis* to represent the addition of dominant vegetation cover by yellow sweet-clover. Nodding wild rye (*Elymus canadensis*) and intermediate wheatgrass (*Elymus hispidus*) also dominated this community type. Other commonly observed species included western-wheat grass, Japanese brome (*Bromus japonicus*), and field pennycress (*Thlaspi arvense*).

Vegetation community Type 3 – Bare Ground/*Salix exigua* was identified in 2014 along both stream banks north of S-426/Hanover Road and was changed in 2015 to community Type 1 – *Salix exigua/Phalaris arundinacea* to represent the shift in vegetation cover from a dominance of bare ground to reed canary grass. Other commonly observed species in this community included American manna grass (*Glyceria grandis*) and yellow sweet-clover, with bare ground representing approximately 6 to 10 percent cover.

Vegetation community Type 4 – *Chenopodium album/Thlaspi arvense* was identified in 2014 north of S-426/Hanover Road and was changed in 2015 to community Type 6 – *Pascopyrum smithii/Melilotus officinalis* to represent the shift in vegetation cover from a dominance of lamb's-quarters and field pennycress to western-wheat grass and yellow sweet-clover. Other commonly observed species in this community included smooth brome (*Bromus inermis*), Japanese brome, and nodding wild rye.

4.2. Stream Bank Vegetation Inventory

The stream bank vegetation inventory identified 35 species along the banks of Little Rock Creek (Table 3). Reed canary grass and coyote willow represented greater than 50% of the vegetation cover along both stream banks in 2015. The Winward stability ratings are based on vegetation communities rather than individual species; therefore, a vegetation community was assigned to each stream bank based on one or more dominant species (Winward, 2000). If the same cover class was recorded for both dominant species in a community type, the higher stability rating was chosen. Success criteria outlined in the monitoring plan state the vegetation along the stream banks will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6. Vegetation community Type 1 –

Salix exigua/Phalaris arundinacea was the dominant vegetation community observed along the stream banks, with an associated Winward stability rating of 9.

Table 3. Comprehensive list of plant species and their associated cover classes along the stream banks of Little Rock Creek at the Judith Slide Repair site in 2014 and 2015.

Streambank Species	Left Bank Upstream	Left Bank Downstream	Right Bank Upstream	Right Bank Downstream	WMVC Indicator Status**	Cover Class
*Phalaris arundinacea**	X	X	X	X	FACW	4
*Salix exigua**	X	X	X	X	FACW	4
Glyceria grandis		X		X	OBL	2
Melilotus officinalis	X	X	X	X	FACU	2
Bare Ground	X	X	X	X	NL	2
Scirpus microcarpus		X			OBL	1
Carex sp.			X	X	NL	1
Veronica americana		X		X	OBL	1
Agastache urticifolia		X	X	X	FACU	1
Bromus inermus		X			FAC	1
Cirsium arvense		X	X	X	FAC	1
Epilobium ciliatum	X	X	X	X	FACW	1
Melilotus albus	X	X	X	X	NL	1
Nasturtium officinale		X		X	OBL	1
Poa palustris			X	X	FAC	1
Artemisia absinthium	X	X	X	X	NL	1
Lactuca serriola			X		FACU	1
*Lepidium campestre***		X			NL	1
Polypogon monspeliensis		X		X	FACW	1
Sonchus arvensis	X	X		X	FACU	1
Thlaspi arvense		X		X	UPL	1
Calamagrostis canadensis		X	X		FACW	0
Prunus virginiana		X			FACU	0
Urtica dioica		X		X	FAC	0
Glyceria striata			X		OBL	0
***Juncus* sp.**		X			NL	0
Cynoglossum officinale		X		X	FACU	0
Euphorbia esula		X		X	NL	0
Hordeum jubatum		X		X	FAC	0
Mentha arvensis		X	X	X	FACW	0
Persicaria amphibia	X	X	X	X	OBL	0
Chenopodium album		X		X	FACU	0
Persicaria maculosa	X	X	X	X	FACW	0
Rumex acetosa		X			FAC	0
Rumex fueginus	X	X	X	X	FACW	0

*Dominant species identified along stream banks
***Lepidium latifolium* was misidentified in 2014 and has been changed to *Lepidium campestre*
New species identified in 2015 are listed in **bold**.

4.3. Noxious Weed Inventory

Three Montana State-listed noxious weeds were observed within the reconstructed segment of Little Rock Creek in 2015 (Table 4). *Lepidium latifolium* was misidentified in 2014, and was removed from the list of noxious weeds observed at this site. Canadian thistle (*Cirsium arvense*) and leafy spurge (*Euphorbia esula*) infestations observed on

site are shown on Figure 3 in Appendix A. Gypsy flower (*Cynoglossum officinale)* was observed in isolated trace amounts, and was therefore not mapped on Figure 3. The combined areal cover of all three noxious weeds identified in 2015 was estimated at 3%. The increase in noxious weeds was primarily observed in riparian areas as opposed to the stream banks, and could potentially be due to dry conditions during the growing season in 2015 allowing weeds to out-compete the native vegetation. Three of the most prolific infestations were observed near the downstream end of the relocated channel segment, along both stream banks, where livestock crosses the channel. Infestations of noxious weeds were observed just outside of the project site during the 2013 monitoring event, which offered a seed source for establishment of weeds within the site.

Table 4. Montana State-listed noxious weeds identified at the Judith Slide Repair site in 2015.

Category*	Scientific Name	Common Name
Priority 2B	*Cirsium arvense*	Canadian Thistle
	Cynoglossum officinale	Gypsy-Flower
	Euphorbia esula	Leafy Spurge

*Based on the Montana Dept. of Agriculture's Noxious Weed List, 2015
Lepidium latifolium was misidentified in 2014 and has been removed from this list of noxious weeds

4.4. Bank Erosion Inventory

The reconstructed channel alignment includes a relatively sharp bend approximately 250' downstream of the newly installed culvert. This bend was constructed using multiple coir wrapped soil lifts over a native gravel toe. The stream has undercut beneath the soil lifts, causing them to begin slumping into the void created. A 10' segment of the left stream bank along this bend is beginning to erode as the coir fabric has begun to degrade and no longer has the strength to hold the bank together (See Additional Photos 13 and 14 in Appendix C). A thin band of vegetation has begun to establish along the toe of the bank, but may not be capable of maintaining the undercut bank over the long term. In general, vegetation establishment along the upper coir fabric lifts is relatively sparse; as a result, this bank may continue to slough into the channel over the next several years until the bank slope stabilizes.

4.5. Perpendicular Transects

Plots of each perpendicular transect surveyed are included in Appendix B. Two transects were surveyed at pools and two at riffles, with maximum depth and bankfull width for each indicated in Table 5. Maximum depths ranged from 4.0 to 5.2 feet while bankfull widths ranged from 21 to 24 feet. Channel depths remain close to the design depth of 4.0 to 4.5 feet (Channel Change Typical Section Detail, Sheet 12).

Repeated surveys in 2014 and 2015 through the two pool transects indicates the development of point bars on the inside of each meander bend. Point bars extended between 1 and 2 feet into the channel at both pools. This bar development is likely to increase scour along the opposite banks and maintain pool habitat on the outside of each meander bend. As the coir fabric begins to biodegrade over the next few years,

continued establishment of vegetation along the toe of the bank should reduce, but not eliminate the potential for erosion along these outside meander bends. Although not surveyed, additional pools have developed within the project reach at outside meander bends and immediately downstream of rock grade control features. These pools provide slower velocity water suitable for utilization by fish of various size classes.

Repeated surveys in 2014 and 2015 indicates some deposition has occurred through the riffle transects. Although only two riffle features were surveyed, both showed higher bed elevations by approximately 0.25'. Results of the longitudinal profile (discussed in next section) and perpendicular transects through pools do not indicate excessive scour through pool habitats that would generate bed material depositing in riffles. It remains to be seen whether the slightly higher bed elevations observed in 2015 may be considered aggradation of the channel bed or temporary deposits of finer material during a below average runoff year. This material may flush out of the channel if a bankfull or larger flood event occurs and lower the bed elevation again. Continued monitoring of all perpendicular transects will assist in determining whether this observation is a trend or a temporary depositional feature.

Table 5. Pool and riffle width and depth at Little Rock Creek stream mitigation site in 2014 and 2015.

Transect	Type	Maximum Depth (ft)		Bankfull Width (ft)	
		2014	2015	2014	2015
1	riffle	4.4	4.2	21.9	21.8
2	pool	5.2	5.1	24.0	24.0
3	riffle	4.4	4.0	21.0	20.8
4	pool	5.7	5.2	20.1	20.1
Average Riffles		**4.4**	**4.1**	**21.5**	**21.3**
Average Pools		**5.5**	**5.2**	**22.1**	**22.1**

4.6. Longitudinal Profile

The longitudinal profile of the channel thalweg reveals the presence of several pool features within the reconstructed channel segment, which are forming by a) scour against the outside meander bends, b) plunging over rock weirs (grade controls) constructed across the channel width, and c) backwatering upstream of the rock grade control features. The weir drop immediately downstream of the culvert has filled in with a mix of gravel, sand, and silt; therefore no pool feature exists through the riprap basin pool feature. Sediment deposition and subsequent vegetation establishment along the channel fringes of the riprap basin pool has also narrowed to more closely match the typical design channel width. Channel gradient upstream and downstream of the project reach appears to closely match the gradient of the reconstructed channel. It should be noted the station labels shown on the profile in Appendix B are based on the survey data collected during the monitoring events and do not match those depicted on the design sheets.

The project included installation of four rock weirs to provide vertical grade control through the reconstructed channel segment. Inspection of each weir indicated no evidence of undercutting or scouring around the rocks placed at each of the locations. Scour downstream of the weirs is developing relatively shallow pools, but does not appear to be jeopardizing the integrity of the weirs (see Photo Points 3.1, 3.2, 4.1, and 4.3 in Appendix C).

4.7. Wildlife Documentation

Five birds, three mammals, four fish, one reptile, and one livestock species have either been directly or indirectly (scat, tracks) observed within the project area (Table 6). In addition, a spotted frog was observed at the confluence of Little Rock Creek with the Judith River, which is approximately 500 feet downstream of the project area.

Table 6. Wildlife species observed at the Judith Slide Repair site in 2014 and 2015.

Common Name	Scientific Name
Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Swallow sp.	*Tachycineta* sp.
American Robin	***Turdus Migratorius***
Western Kingbird	*Tyrannus verticalis*
Mammals	
Cow	*Bovine* sp.
Mule deer	***Odocoileus hemionus***
Deer (tracks)	*Odocoileus* sp.
Mink (tracks and scat)	*Neovison vison*
Fish	
Brown Trout	*Salmo trutta*
Fish sp.	
Mountain Whitefish	*Prosopium williamsoni*
Sculpin	*Cottus* sp.
Reptiles	
Garter Snake	*Thamnophis* sp.

New observations from 2015 are **bolded.**

5.0 ADDITIONAL OBSERVATIONS

The second monitoring visit at this site occurred after the second high flow event following completion of the project. The following is a list of additional observations made during the 2015 site visit:

1. Newly installed fences surrounding the project reach appeared in good condition. No gaps or downed fence strands were observed along the newly installed

fences. The barbed wire fence crossing Little Rock Creek at the downstream end and along the northeast corner of the project is in poor condition and allows livestock to cross into/out of the project reach (See additional Photo 2 in Appendix C). The segments of fence in poor condition were installed well prior to the 2013 MDT project.

2. All rock weirs that were installed during 2013 remain stable and provide added habitat complexity in the form of short pools immediately downstream of each. No evidence of undercutting or shifting rocks was noted.

3. Vegetation establishment along the upper coir fabric lifts remains relatively limited. Much of the coir fabric surfaces remain bare or have been colonized by undesirable and weedy species (See additional Photos 3-13 in Appendix C). It is difficult to determine the cause for lack of vegetation in these areas; however, potential causes include 1) below average precipitation in 2015, 2) an improper seed mix, or 3) no seeding applied to this area. The design calls for seeding the area above the uppermost lift with a wetland seed mix, which may have been inappropriate for such a dry zone. The design does not call for seeding of native fill material placed within the upper two coir lift layers, which is most likely the cause of poor vegetation establishment in this area.

4. Willow establishment along the toe and between the first and second coir soil lifts along the newly constructed banks show excellent survival following two runoff events (See Photo Points 3.1, 3.2, and 4.1, Appendix C).

5. No evidence of a high flow event, such as flood debris or sediment deposits was noted during 2015 monitoring.

6. Evidence of livestock impacts to the channel were only observed at the downstream end of the project reach, where cattle appear to regularly cross the channel. This cattle crossing does not appear to be jeopardizing the success of the project or impairing any of the constructed features of the project.

7. The “basin pool” constructed immediately downstream of the new culvert incorporated a wider channel width, riprapped stream banks, and a weir drop at the culvert outlet. The fringes of this pool have continued to fill with stream bed material and vegetation (See Photo Point 2 and 3.1, Appendix C), although sediment has not accumulated at the culvert outlet. Several other pools were observed throughout the reconstructed channel segment; therefore, the lack of pool formation at this location is not problematic for overall habitat complexity. This pool may not have been successful due to:

    a. The invert elevation of the culvert outlet (3551.29’) matches that of the elevation of the downstream riffle, providing no gradient through the pool feature.

b. The channel through this pool is straight, and otherwise has no features to generate scouring forces against.
c. Channel width through this pool increases from 12' at the culvert outlet to 44' at the downstream riffle crest. Channel width then transitions back to 19' as it enters the reconstructed channel. The abrupt change in channel width within a straight alignment encourages sediment deposition along the channel fringes, which was observed during the monitoring event.

8. A small gully has begun to form across the uplands to the east of the newly constructed channel (See Additional Photos 16-18, Appendix C). This gully appears to be the result of a seep and surface water runoff flowing across newly vegetated areas within the project reach. Straw logs were installed across this gully as part of the 2013 construction, and are partially working to prevent further gully formation. Despite these sediment control measures, fine sediments are entering the channel near the first meander bend downstream of the culvert outlet. Additional monitoring will determine whether this small gully continues to remain a sediment source or stabilizes as vegetation matures along the upland areas adjacent to the channel.

6.0 LITERATURE CITED

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Appendix A

Project Site Maps

MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

CONFLUENCE
consulting incorporated

Legend

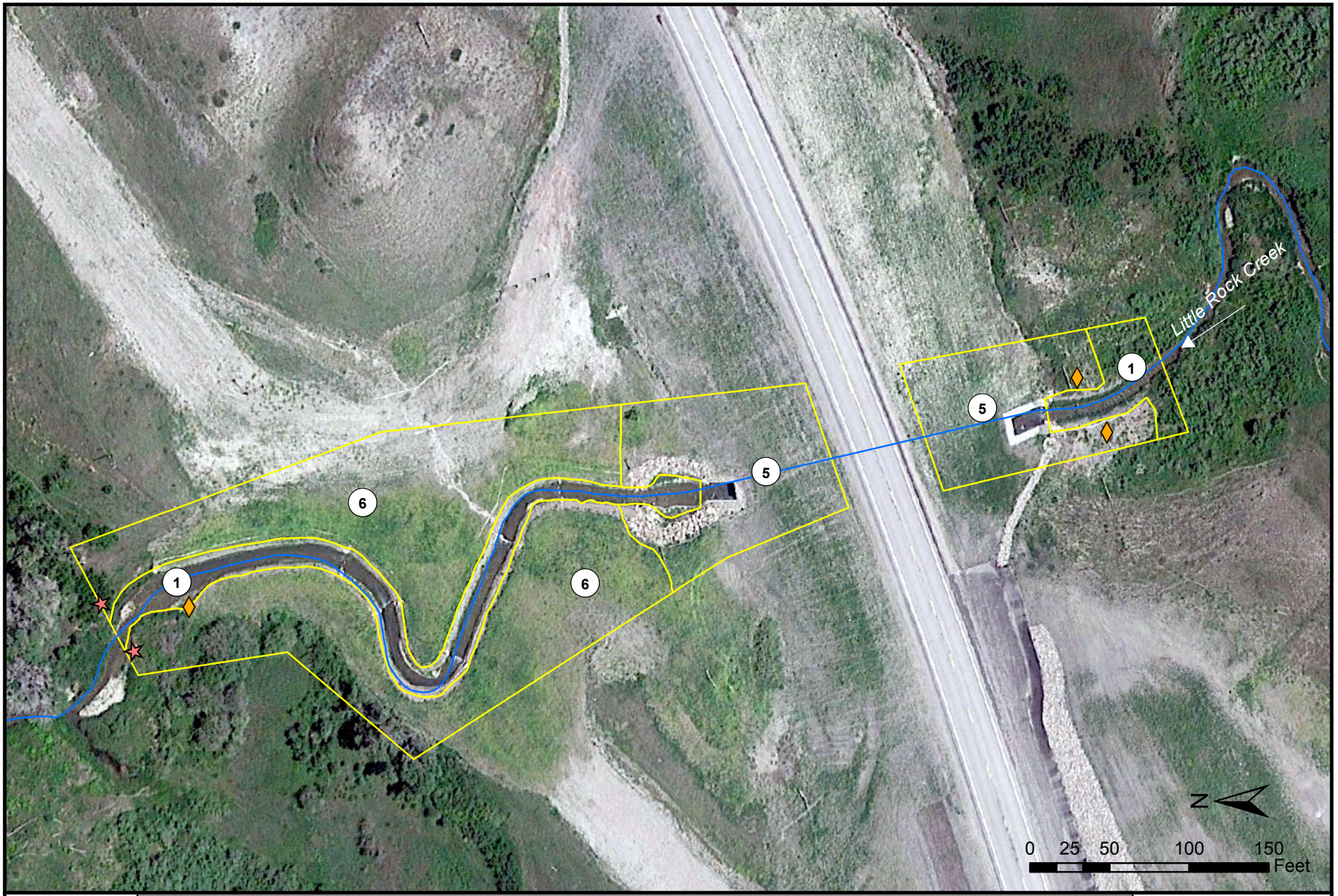
- Photo Points
- Riparian and Perpendicular Transect Endpoints
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Eroding Bank
- Pool and Riffle Transects
- Riparian Transects

2015 Monitoring
Judith Slide

Figure 2

Date: 9/28/2015

Judith_features2015



CONFLUENCE
consulting incorporated

Legend

Channel Centerline

Vegetation Community Boundary

Cirsium arvense

Euphorbia esula

1 Salix exigua/Phalaris arundinacea Community

5 Elymus spp./Melilotus officinalis Community

6 Pascopyrum smithii/Melilotus officinalis Community

2015 Monitoring
Judith Slide

Figure 3

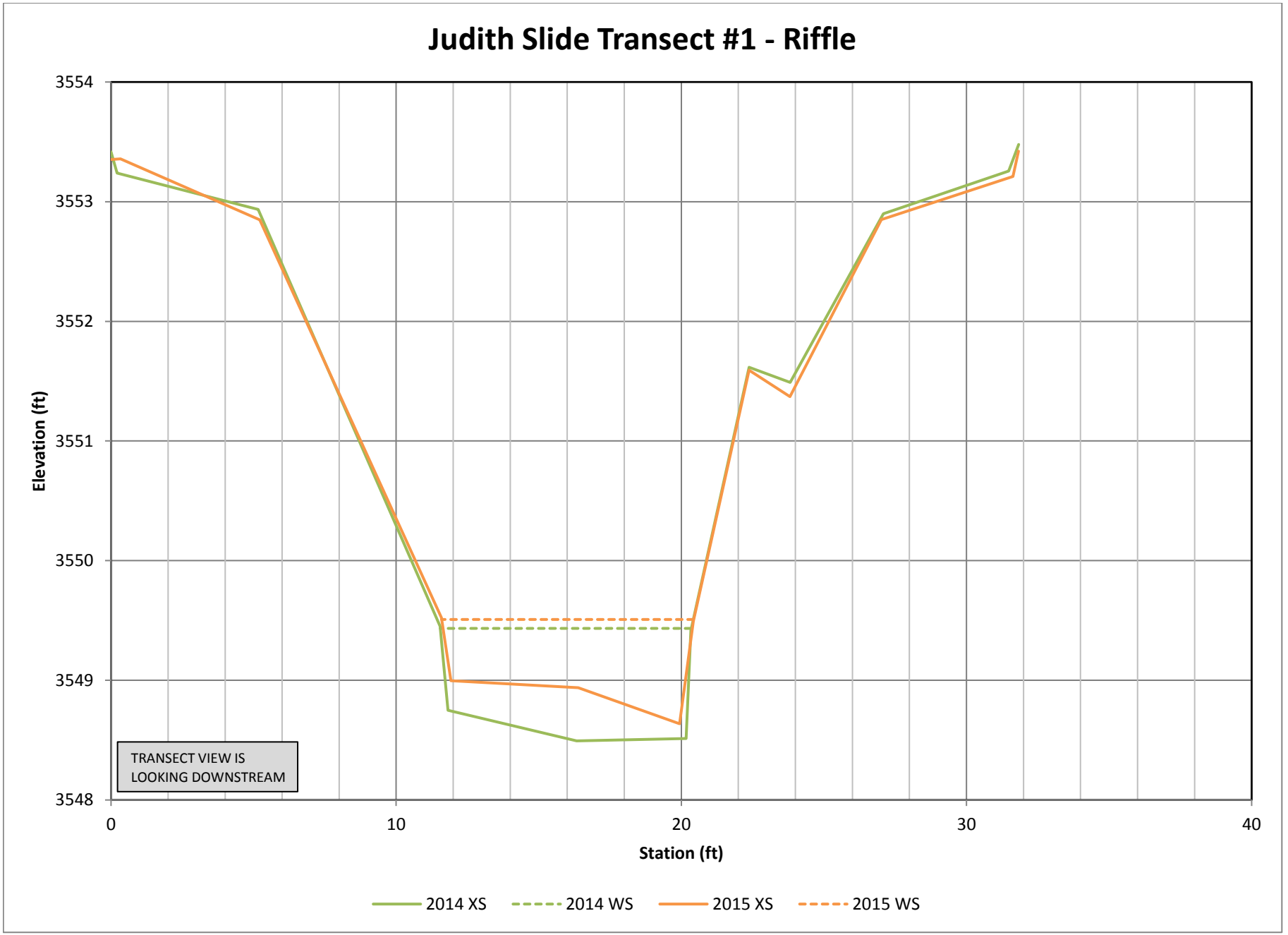
Date: 9/27/2015

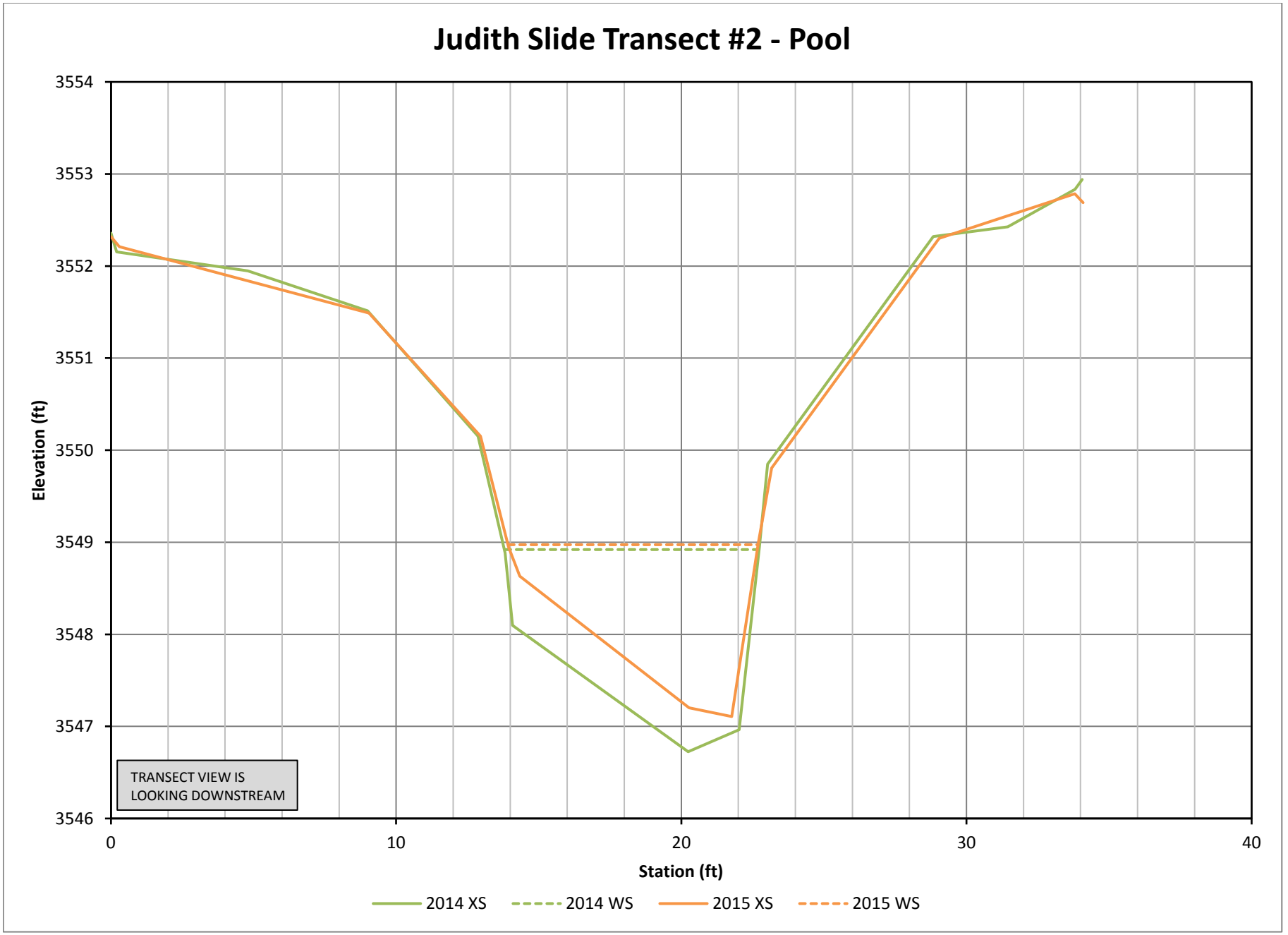
Judith_monitor2015.mxd

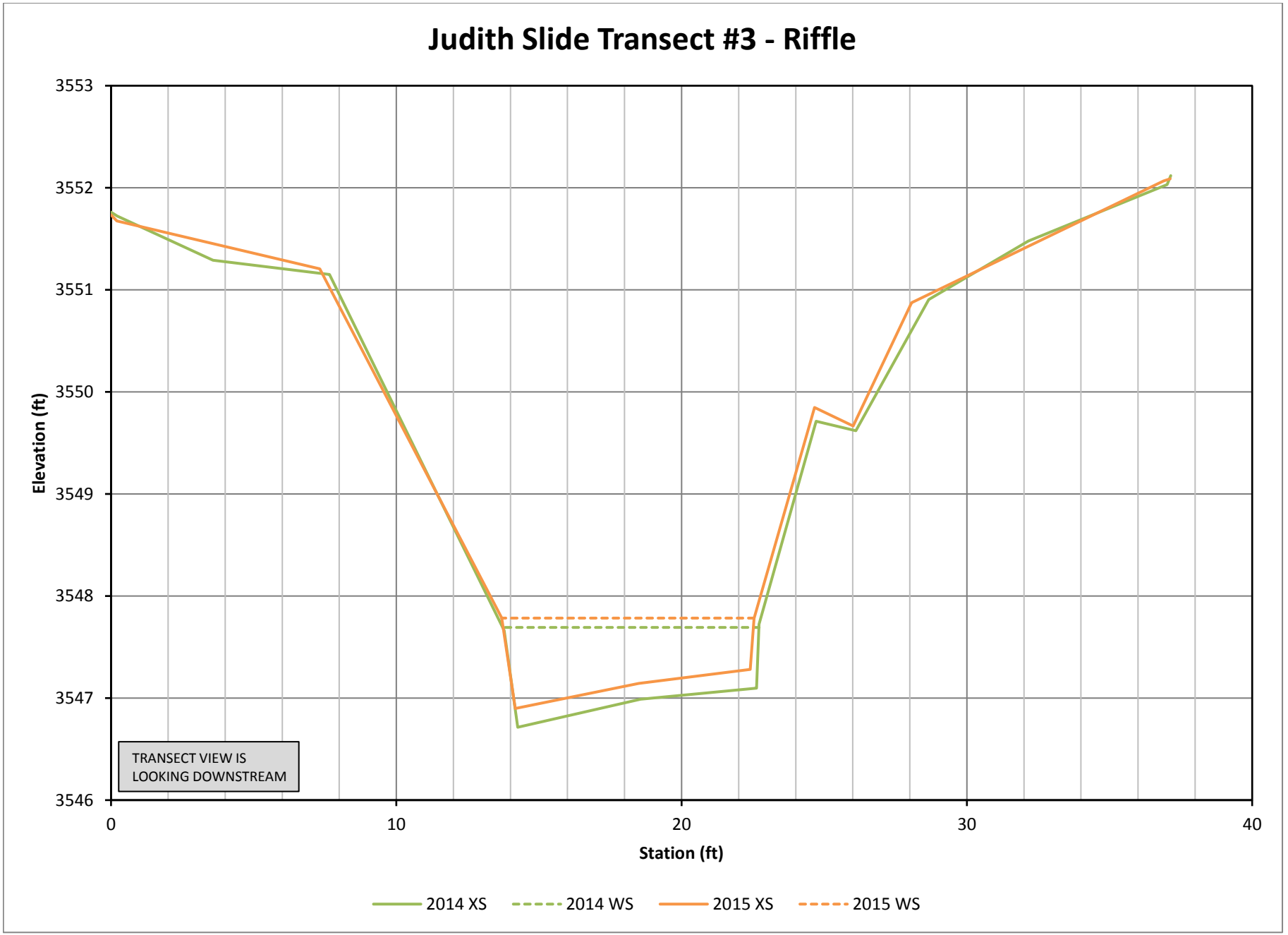
Appendix B

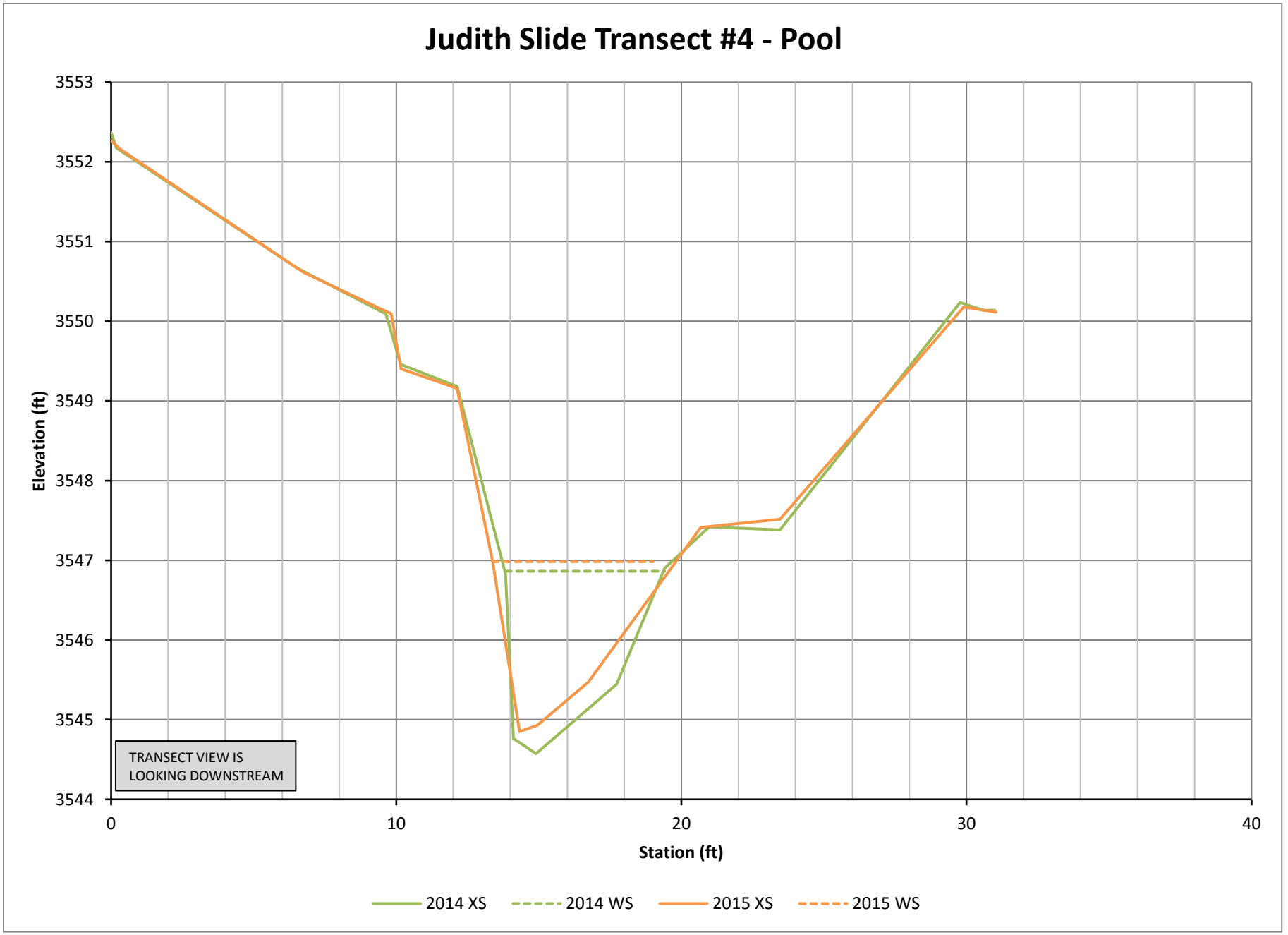
Perpendicular Transect and Longitudinal Profile Plots

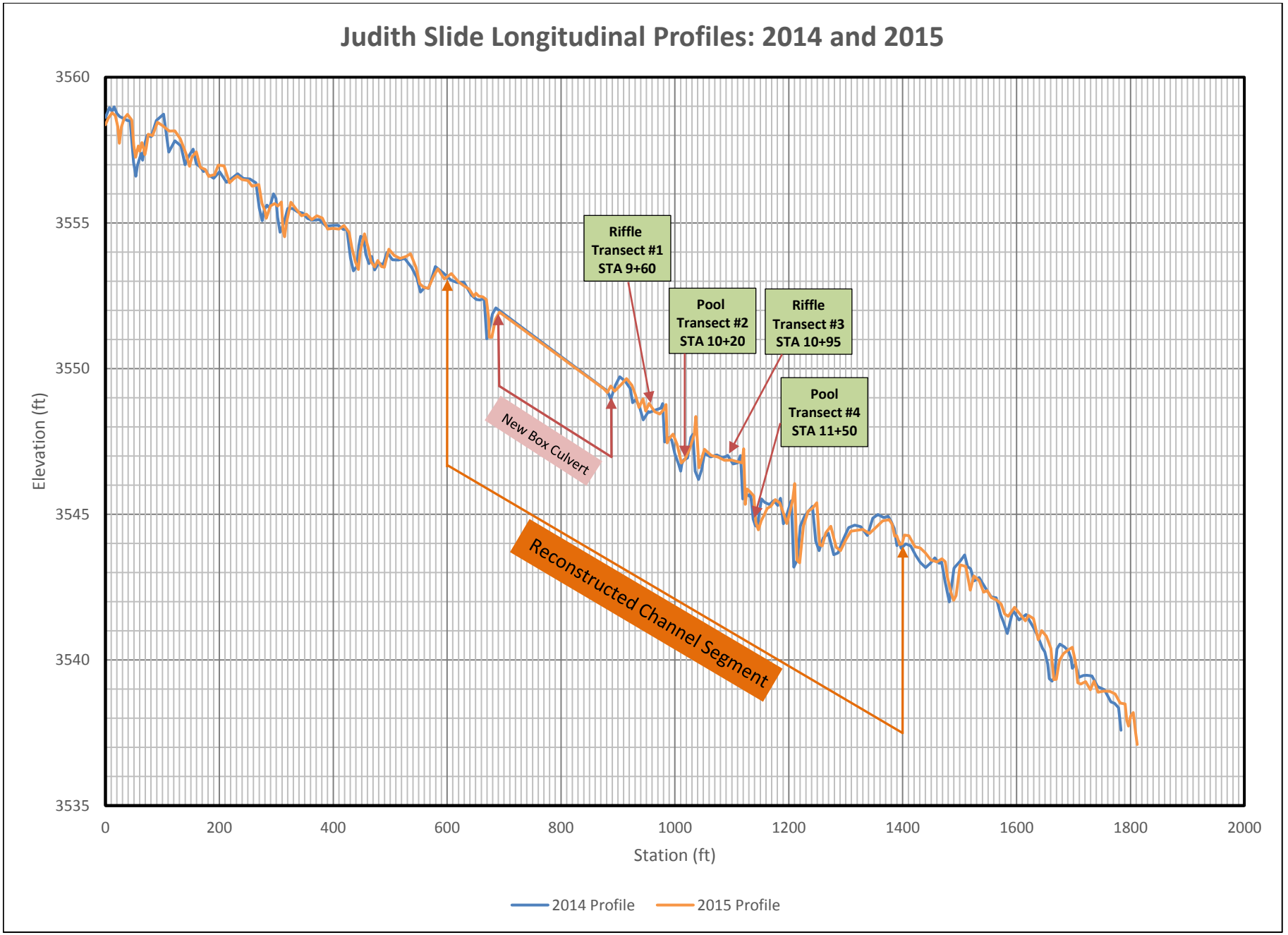
MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana


Judith Slide Transect #1 - Riffle
3554
3553
3552
3551
3550
3549
3548
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS


Judith Slide Transect #2 - Pool
Elevation (ft)
3554
3553
3552
3551
3550
3549
3548
3547
3546
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS


Judith Slide Transect #3 - Riffle
3553
3552
3551
3550
3549
3548
3547
3546
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS


Judith Slide Transect #4 - Pool
3553
3552
3551
3550
3549
3548
3547
3546
3545
3544
Elevation (ft)
0
10
20
30
40
Station (ft)
TRANSECT VIEW IS
LOOKING DOWNSTREAM
2014 XS
2014 WS
2015 XS
2015 WS


Judith Slide Longitudinal Profiles: 2014 and 2015
Elevation (ft)
3560
3555
3550
3545
3540
3535
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Station (ft)
Riffle Transect #1 STA 9+60
Pool Transect #2 STA 10+20
Riffle Transect #3 STA 10+95
Pool Transect #4 STA 11+50
New Box Culvert
Reconstructed Channel Segment
2014 Profile
2015 Profile

Appendix C

Project Area Photos

MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2015 Monitoring Events

CONFLUENCE

Photo Point 1—2014
Description: Upstream end of project looking downstream. **Compass:** 0 (North)

Photo Point 1—2015
Description: Upstream end of project looking downstream. **Compass:** 0 (North)

Photo Point 2—2014
Description: Above culvert outlet, looking downstream.
Compass: 0 (North)

Photo Point 2—2015
Description: Above culvert outlet, looking downstream.
Compass: 0 (North)

Photo Point 3.1—2014
Description: First bend in channel, looking upstream.
Compass: 180 (South)

Photo Point 3.1—2015
Description: First bend in channel, looking upstream.
Compass: 180 (South)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2015 Monitoring Event

CONFLUENCE

Photo Point 3.2—2014
Description: Looking across channel at inside bend.
Compass: 225 (Southwest)

Photo Point 3.2—2015
Description: Looking across channel at inside bend.
Compass: 225 (Southwest)

Photo Point 3.3—2014
Description: Looking downstream at left stream-bank.

Photo Point 3.3—2015
Description: Looking downstream at left stream-bank.

Photo Point 3.4—2014
Description: Looking downstream at right streambank.
Compass: 270 (West)

Photo Point 3.4—2015
Description: Looking downstream at right streambank.
Compass: 270 (West)

PHOTO INFORMATION

PROJECT NAME: Little Rock Creek at Judith Slide Repair

DATE: 2014-2015 Monitoring Event

CONFLUENCE

Photo Point 4.1—2014
Description: Looking upstream.
Compass: 90 (South)

Photo Point 4.1—2015
Description: Looking upstream.
Compass: 90 (South)

Photo Point 4.2—2014
Description: Looking upstream at right streambank.
Compass: 135 (Southeast)

Photo Point 4.2—2015
Description: Looking upstream at right streambank.
Compass: 135 (Southeast)

Photo Point 4.3—2014
Description: Looking downstream.
Compass: 90 (East)

Photo Point 4.3—2015
Description: Looking downstream.
Compass: 90 (East)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2015 Monitoring Event

CONFLUENCE

Photo Point 4.4 — 2014
Description: **Looking downstream at left stream-bank**

Photo Point 4.4 — 2015
Description: **Looking downstream at left stream-bank**

Photo Point 5.1—2014
Description: Downstream end of project, looking up-stream. **Compass:** 180 (South)

Photo Point 5.1—2015
Description: Downstream end of project, looking up-stream. **Compass:** 180 (South)

Photo Point 5.2—2014
Description: Downstream end of project, looking at cattle crossing. **Compass:** 225 (Southwest)

Photo Point 5.2—2015
Description: Downstream end of project, looking at cattle crossing. **Compass:** 225 (Southwest)

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2014-2015 Monitoring Event

CONFLUENCE

Photo Point 5.3—2014
Description: Downstream end of project looking downstream. **Compass:** 270 (West)

Photo Point 5.3—2015
Description: Downstream end of project looking downstream. **Compass:** 270 (West)

Additional Photo 1
Description: **Road Embankment looking east**
Taken in 2015

Additional Photo 2
Description: **Poor fence on NE side of project area**
Taken in 2015

Additional Photo 3
Description: **Poor veg on upper soil lift**
Taken in 2015 looking north @ STA 10+25

Additional Photo 4
Description: **Poor veg on upper soil lift**
Taken in 2015 looking downstream @ STA 10+25

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2015 Monitoring Event

CONFLUENCE

Additional Photo 5
Description: Unvegetated upper soil lift
Taken in 2015 looking across channel @ STA 11+00

Additional Photo 6
Description: Unvegetated upper soil lift
Taken in 2015 looking across channel @ STA 11+00

Additional Photo 7
Description: Unvegetated upper soil lift
Taken in 2015 looking across channel @ STA 11+00

Additional Photo 8
Description: Unvegetated upper soil lift
Taken in 2015 looking downstream @ STA 11+00

Additional Photo 9
Description: Unvegetated upper soil lift
Taken in 2015 looking downstream @ STA 11+25

Additional Photo 10
Description: Unvegetated upper soil lift
Taken in 2015 looking north from STA 11+25

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2015 Monitoring Event

CONFLUENCE

Additional Photo 11
Description: Floodplain south of road embankment
Taken in 2015

Additional Photo 12
Description: New channel alignment
Taken in 2015

Additional Photo 13
Description: Eroding Bank EBL1
Taken in 2015 looking downstream from STA 11+50

Additional Photo 14
Description: Eroding Bank EBL1
Taken in 2015 looking downstream from STA 11+50

Additional Photo 15
Description: Habitat boulders in box culvert
Taken in 2015

Additional Photo 16
Description: Gully forming east of new channel
Taken in 2015

PHOTO INFORMATION

PROJECT SITE: Little Rock Creek at Judith Slide Repair

DATE: 2015 Monitoring Event

CONFLUENCE

Additional Photo 17
Description: Gully forming east of new channel
Taken in 2015

Additional Photo 18
Description: Gully forming east of new channel
Taken in 2015

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

PHOTO POINT 1 LOOKING DOWNSTREAM SOUTH

PHOTO POINT 2 LOOKING DOWNSTREAM NORTH

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

PHOTO POINT 3 LOOKING UPSTREAM SOUTH

PHOTO POINT 3 LOOKING DOWNSTREAM NORTH

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

PHOTO POINT 4 LOOKING UPSTREAM SOUTHEAST

PHOTO POINT 4 LOOKING DOWNSTREAM EAST

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

PHOTO POINT 5 LOOKING UPSTREAM SOUTH

PHOTO POINT 5 LOOKING DOWNSTREAM NORTHWEST

RIPARIAN TRANSECT 2 WEST T4 LT LOOKING DOWNSTREAM EAST

RIPARIAN TRANSECT 2 WEST FENCE POST LOOKING UPSTREAM SOUTH

RIPARIAN TRANSECT 1 EAST T4 RT LOOKING UPSTREAM SOUTH

RIPARIAN TRANSECT 1 EAST FENCE POST LOOKING DOWNSTREAM

T1 LT: LOOKING UPSTREAM SOUTH

T1 LT: LOOKING DOWNSTREAM NORTH

T1 LT: LOOKING EAST TO T1 RT:

T1 RT: LOOKING WEST TO T1 LT:

T1: LOOKING UPSTREAM SOUTH FROM MIDDLE OF CREEK

T1: LOOKING DOWNSTREAM NORTH FROM MIDDLE OF CREEK

T1 RT: LOOKING UPSTREAM SOUTHWEST

T1 RT: LOOKING DOWNSTREAM NORTH

T2 LT: LOOKING UPSTREAM SOUTH

T2 LT: LOOKING DOWNSTREAM WEST

T2 LT: LOOKING EAST TO T2 RT

T2 RT: LOOKING WEST TO T2 LT

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

T2: LOOKING UPSTREAM SOUTH FROM MIDDLE OF CREEK

T2: LOOKING DOWNSTREAM NORTHWEST FROM MIDDLE OF CREEK

T2 RT: LOOKING UPSTREAM SOUTHWEST

T2 RT: LOOKING DOWNSTREAM NORTHWEST

T3 LT: LOOKING UPSTREAM SOUTHEAST

T3 LT: LOOKING DOWNSTREAM NORTH

T3 LT: LOOKING EAST TO T3 RT

T3 RT: LOOKING WEST TO T3 LT

T3: LOOKING UPSTREAM SOUTHEAST FROM MIDDLE OF CREEK

T3: LOOKING DOWNSTREAM NORTHWEST FROM MIDDLE OF CREEK

T3 RT: LOOKING UPSTREAM SOUTH

T3 RT: LOOKING DOWNSTREAM WEST

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

T4 LT: LOOKING UPSTREAM SOUTHEAST

T4 LT: LOOKING DOWNSTREAM EAST

PROJECT NAME: 2015 MDT STREAM MITIGATION—JUDITH SLIDE

DATE: 7-30-15

T4 LT: LOOKING EAST TO T4 RT

T4 RT: LOOKING WEST TO T4 LT

T4: LOOKING UPSTREAM SOUTHEAST FROM MIDDLE OF CREEK

T4: LOOKING DOWNSTREAM NORTHEAST FROM MIDDLE OF CREEK

T4 RT: LOOKING UPSTREAM SOUTH

T4 RT: LOOKING DOWNSTREAM EAST

Appendix D

As-Built Topographic Survey (surveyed in 2014)

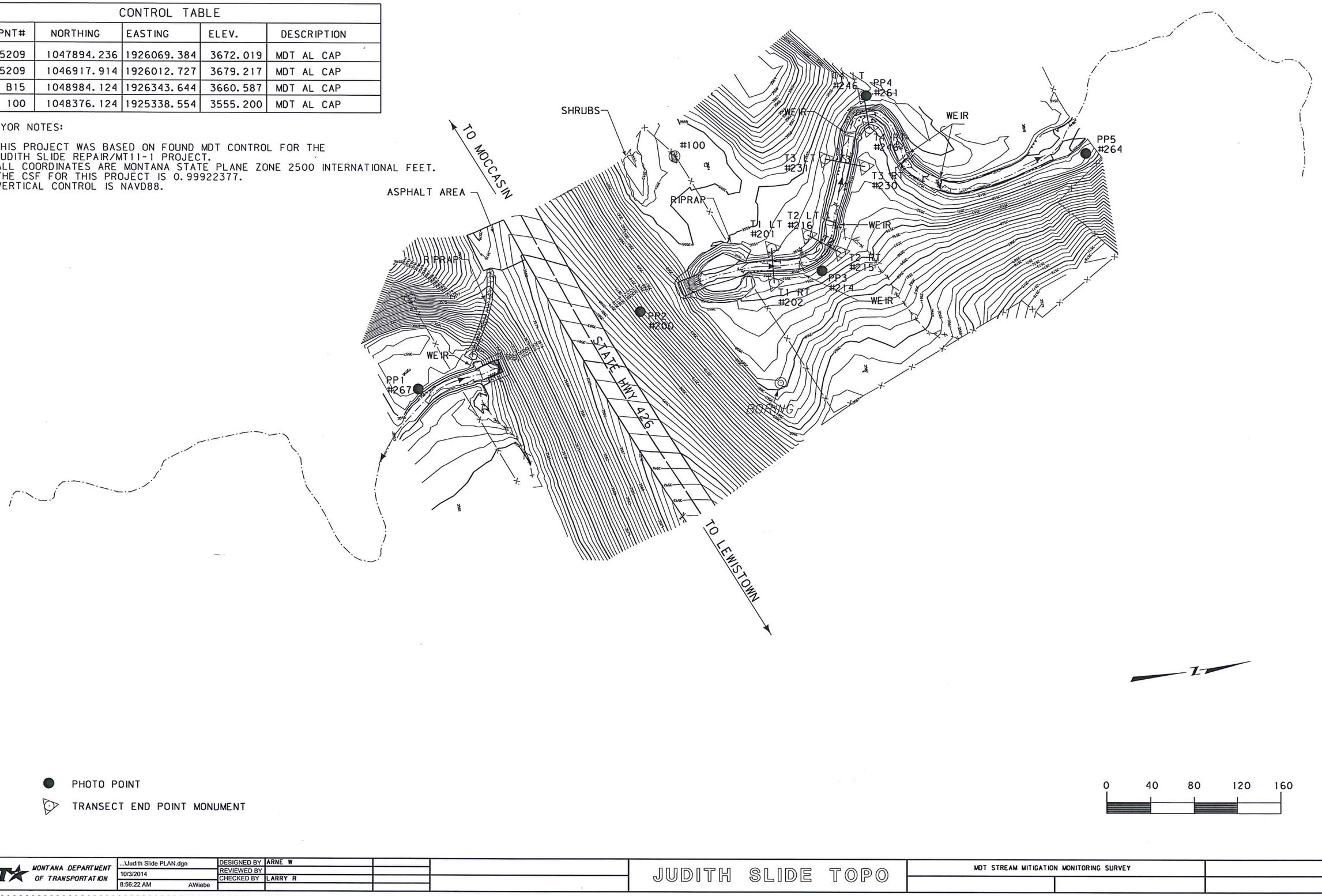
MDT Stream Mitigation Monitoring
Little Rock Creek at Judith Slide
Fergus County, Montana

CONTROL TABLE				
PNT#	NORTHING	EASTING	ELEV.	DESCRIPTION
A5209	1047894.236	1926069.384	3672.019	MDT AL CAP
B5209	1046917.914	1926012.727	3679.217	MDT AL CAP
B15	1048984.124	1926343.644	3660.587	MDT AL CAP
100	1048376.124	1925338.554	3555.200	MDT AL CAP

SURVEYOR NOTES:

1. THIS PROJECT WAS BASED ON FOUND MDT CONTROL FOR THE JUDITH SLIDE REPAIR/MT11-1 PROJECT.
   ALL COORDINATES ARE MONTANA STATE PLANE ZONE 2500 INTERNATIONAL FEET.
   THE CSF FOR THIS PROJECT IS 0.99922377.
   VERTICAL CONTROL IS NAVD88.

STAHLY ENGINEERING & ASSOCIATES
STAHLY
CIVIL ENGINEERS
STAHLY BUILDING
BILLINGS, MONTANA



● PHOTO POINT

TRANSECT END POINT MONUMENT

0 40 80 120 160

3	MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\Judith Slide PLAN.dgn	DESIGNED BY	ARNE W		JUDITH SLIDE TOPO	MDT STREAM MITIGATION MONITORING SURVEY
2		10/3/2014	REVIEWED BY				
1		8:56:22 AM AWiebe	CHECKED BY	LARRY R			