MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Bowser Creek
Flathead County, Montana

Project Completed: 2010
Monitoring Report #2: December, 2014

Prepared for:

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Helena, MT 59620-1001

Prepared by:

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MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT #2

YEAR 2014

Bowser Creek
Flathead County, Montana

MDT Project Number: NH 15(93)
Control Number: 2038-011

USACE Number: NWO-2009-01808-MTM

Prepared for:

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1.0 INTRODUCTION

As part of construction of the Kalispell Bypass U.S. Highway 2 South, the Montana Department of Transportation (MDT) modified a segment of Bowser Creek to allow for highway widening and improved traffic. In order to mitigate the impacts of this project, MDT proposed on-site stream mitigation actions within the widened highway right of way. The following report includes the results of the second year of post-project monitoring of the on-site mitigation actions along the modified segment of Bowser Creek. This monitoring report includes an evaluation of monitoring results in comparison to project performance standards outlined in the post-construction monitoring plan for the site. Mitigation is to be monitored for five years to evaluate compliance toward meeting these performance standards. The project was constructed in 2010; therefore, these results provide documentation of the site's condition four years following the project's completion.

Bowser Creek had been modified over decades to fit between the original Highway 2 alignment and residential development. Additional MDT right-of-way was acquired to provide additional space to relocate the stream away from the widened road footprint. The relocation of Bowser Creek was permitted in a modification to U.S. Army Corps (USACE) permit NWO-2009-018098-MTM. The project included placement of 0.267 acres of wetland fill in the original Bowser Creek channel and 709 feet of stream impacts from relocating 429 feet of the channel and placing a 218-foot segment of the creek into a culvert beneath the Highway 2 intersection with Highway 93.

The overall goal of the project is to provide compensatory mitigation for stream impacts associated with the U.S. Highway 2 widening segment of the Kalispell Bypass in the Missoula District. Specific objectives intended to achieve this goal include:

- Construct 430 linear feet of new Bowser Creek channel slightly north of the existing channel
- Lay back floodplain slopes adjacent to the channel from 1.5:1 to a 4:1 slope or flatter
- Implement an aggressive revegetation plan to re-establish native riparian and upland vegetation which may include salvage of existing wetland soils and plant material

If successful, the project will create, enhance, restore, and maintain permanent, naturally self-sustaining, native or native-like stream and riparian habitat. The project is designed to protect the functional values of riparian lands, floodplains, wetlands, and uplands for the benefit of fish and wildlife habitat, water quality, floodwater retention, groundwater recharge, open space, aesthetic values, and environmental education. Provisions outlined in the USACE permit include monitoring of mitigation areas for five years following channel construction to determine whether the site is meeting, or moving toward meeting a series of performance criteria outlined in the monitoring plan and described below.

Quantitative success criteria for Bowser Creek:

1. **Riparian Buffer Success** will be achieved when
    a. Woody and riparian vegetation becomes established, and noxious weeds do not exceed 10% cover within the riparian buffer areas.
    b. Any area within the creditable buffer area disturbed by the project construction must have at least 50% areal cover of non-noxious weed species by the end of the monitoring period.

2. **Vegetation Success** will be achieved when
    a. Combined areal cover of riparian and streambank vegetation communities is ≥70%
    b. Planted trees and shrubs will be considered successful where they exhibit 50% survival after 5 years.

3. **Vegetation along Streambanks** will be considered successful when banks are vegetated with a majority of deep-rooting riparian plant species having root stability indices ≥6 (subject to 1.a and 1.b above).

4. **Streambank Stability Success** will be achieved where; following restoration, less than 25% of bank length is unstable and classified as eroding bank. For this purpose "eroding bank" will be defined as any bank greater than two feet in length that is more than 50% bare mineral soil and has no roots, surface vegetation, or other stabilizing structure (e.g. rock, woody debris) to inhibit erosion.

Qualitative performance criteria for Bowser Creek:

5. **Channel Form Success** will be achieved when the stream stabilizes, includes pools and riffles, allows for flood events to occupy the floodplain, and the habitat features such as riparian plant communities have successfully established along streambanks.

Additional reporting requirements:

6. **Photo Documenting** success of restored stream channel and streambank vegetation community development showing distinct positive changes from pre-construction to final monitoring year in comparison with the establishment reference reach.

Results of the second year monitoring at the Bowser Creek stream mitigation site are presented in Section 4 and compared to performance standards in Section 5. Section 6 provides management recommendations to maximize the potential for meeting all performance standards at this and other similar mitigation sites. Additional reporting requirements including a longitudinal profile, repeated survey results at four perpendicular transects, a planting schematic from the approved design, photo documentation of the project site, and maps indicating the endpoints of riparian belt transects, perpendicular transect surveys and locations of noxious weed infestations are included as Appendices to this report.

2.0 SITE LOCATION

The modified segment of Bowser Creek flows east within a newly constructed channel immediately north of U.S. Hwy 2 near the intersection of U.S. Highway 2 and Alternate Highway 93 (Figure 1). This monitoring site is located in Section 12, Township 28 North, Range 22 West, in Flathead County, Montana.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on August 22, 2014 while survey crews visited the site on July 29, 2014. The following data were collected at the Bowser Creek stream mitigation site:

3.1. Vegetation Inventories and Community Mapping

Two riparian belt transects established during the first monitoring event in 2013 were resurveyed to document areal percent cover of total vegetation, woody vegetation, and noxious weeds. The riparian belt transect on the right (south) stream bank is 204 feet long; while the left (north) bank is 167 feet long (Figure 3, Appendix A).

A vegetation inventory was conducted along both stream banks, and included documenting dominant species presence, percent cover of each species, and a list of all plant species observed within three feet of the active channel. The stream bank vegetation inventory included the entire length of both banks (3 feet wide) within the project reach. In 2013, plant species identified along the stream banks were assigned plant stability ratings based on Winward, 2000. In 2014, plant species identified along the stream banks were assigned plant stability ratings based on Burton *et al*., 2011. This change was made per MDT request to use updated values for plant stability ratings.

The project site was visually inspected to document the presence of noxious weeds. Noxious weed infestations were mapped on aerial photographs, with species noted (Figure 4, Appendix A). Observations of isolated noxious weeds were noted in the species lists, but not mapped.

The project area was visually inspected to document woody vegetation plantings. The inspection included recording the total number of live and dead woody plantings observed. Based on the vegetation surveys and visual inspections, dominant vegetation communities within the project area were mapped on aerial photos to document vegetative establishment within upland and riparian zones.

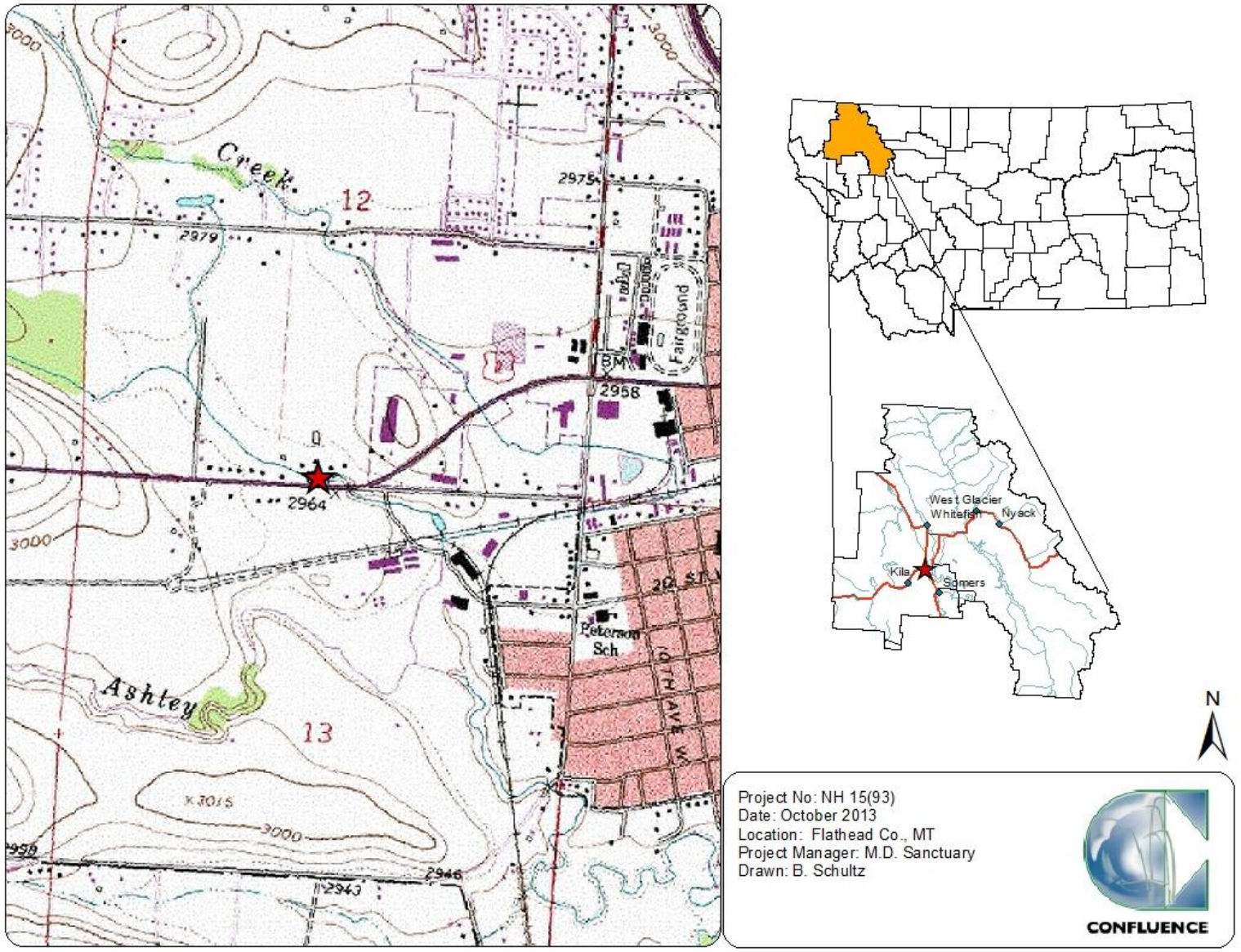


Figure 1. Project location of Bowser Creek stream mitigation site.

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 2013 were re-surveyed by licensed survey crews; two at riffles and two at pools. A longitudinal profile of the channel thalweg was surveyed to document bedform complexity and aquatic habitat conditions.

3.4. Photo Documentation

Photo documentation of the site was repeated at several locations to document vegetation establishment and stream bank conditions. Three photo documentation points were established during the 2013 monitoring event to document changes in the site over time. Additional photos were taken facing upstream, downstream, left and right from the center of the channel, and at the endpoints of each perpendicular transect.

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 Streambank 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. In 2014 the total percent riparian cover was 100%, with 11% woody coverage and 7% noxious weed coverage. No bare ground was observed along the riparian transects in 2014 or 2013.

Dominant species recorded along the riparian and streambank transects were combined with visual observations in other areas to develop a vegetation community map (Figure 4, Appendix A). The upper side slopes of the project are dominated by wild rye (*Elymus spp.*), while the lower slopes and riparian zones adjacent to the channel are dominated by reed canary grass (*Phalaris arundinacea*).

Table 1. Percent cover of vegetation transects at Bowser Creek in 2013 and 2014.

Belt Transect	Length (ft)	Total % Vegetation Cover		% Woody Cover		% Noxious Weed Cover	
		2013	2014	2013	2014	2013	2014
Right (South) Riparian	204	100%	100%	2%	5%	2%	5%
Left (North) Riparian	167	100%	100%	14%	15%	5%	10%
Riparian Subtotal		100%	100%	8%	10%	4%	7%
Right (South) Stream bank	465	100%	100%	17%	20%	4%	5%
Left (North) Stream bank	465	100%	100%	12%	10%	4%	10%
Stream bank Subtotal		100%	100%	15%	15%	4%	8%
Area Weighted Total		100%	100%	9%	11%	3%	7%

Table 2 is a comprehensive list of plant species observed on site during the 2013 and 2014 monitoring events. In 2014, 83 plant species were observed, representing an increase by 28 species from the 2013 monitoring event. In 2014, 48% of the species observed were hydrophytic based on the 2014 National Wetland Plant List (NWPL) (Lichvar *et al*., 2014).

4.2. Stream Bank Vegetation Composition

During the 2014 monitoring event, 50 plant species were observed along Bowser Creek's stream banks (within 3 feet of the active channel), representing an increase of 21 species from 2013 (Table 3). Stability ratings were assigned to each species observed along the banks to help determine overall bank stability. Stability ratings are based on a scale ranging from 1 to 10, and indicate a plant's ability to resist erosive forces based on root characteristics (Burton *et al*., 2011). Of the 50 plants observed, 32 have stability indices provided by Burton *et al*., while the remaining 18 species do not. Scores for plants without stability indices are listed in Table 3 as N/A. Ten of the 32 species (31%) with assigned stability indices scored 6 or higher. The dominant species observed along the banks were reed canary grass (*Phalaris arundinacea*) and watercress (*Nasturtium officinale*), which have stability indices of 9 and N/A respectively. Reed canary grass comprised >50% cover on both banks.

Table 2. Comprehensive vegetative species list for Bowser Creek stream mitigation site in 2013 and 2014

Scientific Name	Common Name	WMVC Indicator Status*
Achillea millefolium	Common Yarrow	FACU
Agastache urticifolia	**Nettle-Leaf Giant-Hyssop**	**FACU**
Agropyron cristatum	Crested Wheatgrass	NL
Agrostis gigantea	Black Bent	FAC
Alnus incana	Speckled Alder	FACW
Alopecurus arundinaceus	Creeping Meadow-Foxtail	FAC
Artemisia biennis	Biennial Wormwood	FACW
Beckmannia syzigachne	American Slough Grass	OBL
Betula pumila	**Bog Birch**	**OBL**
Bromus inermis	Smooth Brome	FAC
Carduus nutans	**Nodding Plumeless-Thistle**	**UPL**
Carex nebrascensis	**Nebraska Sedge**	**OBL**
Carex sp.	**Sedge**	**NL**
Carex stipata	**Stalk-Grain Sedge**	**OBL**
Carex utriculata	Northwest Territory Sedge	OBL
Centaurea cyanus	**Garden Cornflower**	**FACU**
Centaurea stoebe	**Spotted Knapweed**	**NL**
Chamerion angustifolium	**Fireweed**	**NL**
Chenopodium album	Lamb's-Quarters	FACU
Cicuta douglasii	**Western Water-Hemlock**	**OBL**
Cirsium arvense	Canadian Thistle	FAC
Cirsium vulgare	Bull Thistle	FACU
Cornus alba	Red Osier	FACW
Cynoglossum officinale	Gypsy-Flower	FACU
Descurainia sophia	**Herb Sophia**	**NL**
Elymus canadensis	Nodding Wild Rye	FAC
Elymus cinereus	**Great Basin Wildrye**	**NL**
Elymus repens	Creeping Wild Rye	FAC
Epilobium ciliatum	Fringed Willowherb	FACW
Equisetum arvense	Field Horsetail	FAC
Geum macrophyllum	**Large-Leaf Avens**	**FAC**
Geum sp.	**Avens**	**NL**
Geum triflorum	Old-Man's-Whiskers	FACU
Glyceria striata	Fowl Manna Grass	OBL
Helianthus maximiliani	Maximilian Sunflower	UPL
Helianthus nuttallii	**Nuttall's Sunflower**	**FACW**
Hordeum jubatum	**Fox-Tail Barley**	**FAC**
Hypericum perforatum	**Common St. John's-Wort**	**FACU**
Juncus balticus	**Baltic Rush**	**FACW**
Juncus sp.	**Rush**	**NL**
Lactuca serriola	Prickly Lettuce	FACU
Lemna minor	Common Duckweed	OBL
Leucanthemum vulgare	Ox-Eye Daisy	FACU
Lysichiton americanus	Yellow-Skunk-Cabbage	OBL
Medicago lupulina	Black Medick	FACU
Medicago sativa	Alfalfa	UPL
Melilotus albus	**White Sweetclover**	**NL**
Melilotus officinalis	Yellow Sweet-Clover	FACU
Mentha arvensis	American Wild Mint	FACW
Nasturtium officinale	Watercress	OBL
Onopordum acanthium	Scotch Thistle	NL
Pascopyrum smithii	Western-Wheat Grass	FACU
Persicaria sp.	**Smartweed**	**NL**
Phalaris arundinacea	Reed Canary Grass	FACW
Plantago lanceolata	English Plantain	FACU
Plantago major	Great Plantain	FAC
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Prunus virginiana	**Choke Cherry**	**FACU**
Ranunculus sp.	Buttercup	NL
Rosa woodsii	Woods' Rose	FACU
Rudbeckia hirta	**Black-Eyed-Susan**	**FACU**
Rumex crispus	Curly Dock	FAC
Salix bebbiana	Gray Willow	FACW
Salix drummondiana	Drummond's Willow	FACW
Salix exigua	Narrow-Leaf Willow	FACW
Salix sp.	**Willow**	**NL**
Silene vulgaris	**Maiden's-tears**	**NL**
Solanum dulcamara	**Climbing Nightshade**	**FAC**
Solidago canadensis	Canadian Goldenrod	FACU
Sonchus arvensis	Field Sow-Thistle	FACU
Symphoricarpos albus	Common Snowberry	FACU
Tanacetum vulgare	Common Tansy	FACU
Taraxacum officinale	Common Dandelion	FACU
Thlaspi arvense	Field Pennycress	UPL
Tragopogon dubius	**Meadow Goat's-beard**	**NL**
Trifolium pratense	Red Clover	FACU
Trifolium repens	White Clover	FAC
Triglochin maritima	Seaside Arrow-Grass	OBL
Typha latifolia	Broad-Leaf Cat-Tail	OBL
Urtica dioica	Stinging Nettle	FAC
Verbascum thapsus	Great Mullein	FACU
Vicia americana	American Purple Vetch	FAC

*Based on 2014 NWPL (Lichvar *et al*., 2014)
New species identified in 2014 are **bolded**.

Table 3. Comprehensive list of plant species and accompanying stability index values (from Burton *et al*., 2011) for Bowser Creek stream mitigation site in 2014.

Streambank Species	Left bank	Right bank	WMVC Indicator Status**	Stability Index
*Phalaris arundinacea**	X	X	FACW	9
Carex nebrascensis	X		OBL	8.5
Carex utriculata	X		OBL	8.5
Juncus balticus	X		FACW	8.5
Salix bebbiana	X		FACW	8.5
Typha latifolia	X	X	OBL	8.5
Urtica dioica		X	FAC	8.5
Cornus alba	X		FACW	8
Alnus incana		X	FACW	7
Alopecurus arundinaceus	X	X	FAC	6
Carex sp.	X	X	NL	5
Equisetum arvense		X	FAC	5
Glyceria striata		X	OBL	5
Pascopyrum smithii		X	FACU	5
Plantago major	X		FAC	5
Salix sp.		X	NL	5
Vicia americana	X		FAC	5
Bromus inermis	X		FAC	2
Centaurea stoebe		X	NL	2
Cirsium arvense	X	X	FAC	2
Cynoglossum officinale	X		FACU	2
Geum macrophyllum	X	X	FAC	2
Hordeum jubatum	X		FAC	2
Melilotus albus	X	X	NL	2
Melilotus officinalis		X	FACU	2
Mentha arvensis	X	X	FACW	2
*Nasturtium officinale**	X	X	OBL	2
Onopordum acanthium	X		NL	2
Poa palustris	X	X	FAC	2
Solanum dulcamara		X	FAC	2
Rumex crispus	X	X	FAC	2
Trifolium repens		X	FAC	2
Agastache urticifolia	X	X	FACU	N/A
Beckmannia syzigachne	X		OBL	N/A
Chamerion angustifolium		X	NL	N/A
Chenopodium album		X	FACU	N/A
Cicuta douglasii	X	X	OBL	N/A
Descurainia sophia		X	NL	N/A
Helianthus maximiliani	X		UPL	N/A
Helianthus nuttallii		X	FACW	N/A
Hypericum perforatum	X		FACU	N/A
Lactuca serriola	X		FACU	N/A
Medicago lupulina	X		FACU	N/A
Medicago sativa		X	UPL	N/A
Persicaria sp.	X		NL	N/A
Silene vulgaris		X	NL	N/A
Sonchus arvensis		X	FACU	N/A
Tanacetum vulgare	X		FACU	N/A
Tragopogon dubius	X		NL	N/A
Trifolium pratense		X	FACU	N/A

**dominant species observed along Bowser Creek stream banks*
**Based on 2014 NWPL (Lichvar *et al*., 2014)

4.3. Noxious Weed Inventory

The Bowser Creek field assessment identified the presence of six Montana State-listed noxious weeds (Table 4). All noxious weed species observed are shown on Figure 4 in Appendix A with the exception of those observed in trace amounts, which were not mapped. The combined cover of all six noxious weeds identified in 2014 was 7%, an increase of 4% from the 2013 monitoring event. Infestations of *Cirsium arvense*, the most prevalent weed, were primarily located on the northeast and southwest ends of the project area (Figure 4).

Table 4. Montana State-listed noxious weed species observed in 2014 at the Bowser Creek Stream Mitigation Site.

Category*	Scientific Name	Common Name
Priority 2B	*Centaurea stoebe*	Spotted Knapweed
	Cirsium arvense	Canadian Thistle
	Cynoglossum officinale	Gypsy-Flower
	Hypericum perforatum	Common St. John's-Wort
	Leucanthemum vulgare	Ox-Eye Daisy
	Tanacetum vulgare	Common Tansy

*Based on the MSU Extenstion Services' Noxious Weed List, 2013

4.4. Woody Plant Survival

Willows, alder, dogwood, snowberry, chokecherry, birch, and Wood's rose were observed as planted woody vegetation species. Table 5 indicates a plant survival percentage of 94% for woody plants located in 2014, a decrease by 2% from 2013 observations. Due to their relatively small size and high density of herbaceous growth along the riparian and upland zones, many planted woody shrubs may not have been found during monitoring.

Table 5. Woody plant survival at Bowser Creek stream mitigation site in 2013 and 2014.

Year	Total Plants Inspected	Surviving Plants	Woody Planting Survival
2013	127	122	96%
2014	127	119	94%

4.5. Bank Erosion Inventory

Total eroding stream bank length was 149 feet, or 17% of the overall project bank length of 878 feet. Photos of each eroding bank are included in Appendix C of this report. Figure 3 in Appendix A shows the GIS mapped location of eroding stream banks.

Eroding stream bank EBL1 and EBL2 are located upstream (EBL1) and downstream (EBL2) of a culvert entering Bowser Creek from the north. Stone placed underneath the

culvert to the toe of the stream bank was installed to prevent localized bank erosion from flows through the culvert; however, this material was not placed far enough up or downstream and erosion is occurring as a result. Fine grained soils are becoming saturated and sloughing during high flow events from the culvert. Erosion severity is considered low at EBR1 and moderate at EBR2.

Erosion along the right (south) bank at EBR1 includes bank sloughing across the channel from the culvert. Bank erosion at this location is likely due to fine grained soils becoming saturated and sloughing when the culvert discharges into Bowser Creek. This bank has retreated approximately 3 feet following the previous monitoring event in 2013. Bank erosion severity at EBR1 is considered moderate.

Eroding bank EBR2 is located near the upstream end of the project site where the channel appears to be widening to better access the floodplain. Bank erosion is likely occurring due to fine grained soils and steep stream bank slopes. The bank has retreated approximately 2 feet since 2013. Erosion severity at this bank is considered low.

4.6. Perpendicular Transect Surveys

Two transects were surveyed at pools and two at riffles, with maximum depth and bankfull width for each indicated in Table 6. These results indicate variability in channel dimensions, with maximum bankfull depths ranging from 1.9 to 4.1 feet and bankfull widths ranging from 8.2 to 16 feet. The range of channel widths and depths observed by these transects indicates the establishment of variable habitat elements throughout the reach.

Table 6. Pool and riffle width and depth at Bowser Creek stream mitigation site in 2013 and 2014.

Transect	Type	Max Depth (ft)		Bankfull Width (ft)	
		2013	2014	2013	2014
1	Pool	1.7	1.9	6.3	9.5
2	Riffle	2.5	2.9	14.7	16
3	Pool	3.6	4.1	14.8	14.3
4	Riffle	1.9	2.1	7.4	8.2
Average Riffles		2.4	2.5	11.1	12.1
Average Pools		2.7	3.0	9.0	11.9

Surveyed pool depths were 1.9 feet (transect #1) and 4.1 feet (transect #3). Pool design depth was 2.7 feet, indicating the pool at transect #1 is relatively shallow, while the pool at transect #3 is relatively deep. Depths at riffles were 3.0 feet (transect #2) and 2.1 feet (transect #4), which were deeper than the design depth of 1.7 feet.

Plots for each surveyed transect (Appendix B) reveal relatively trapezoidal channel shapes for both pools and riffles. This pattern of symmetrical channel cross section shape provides evidence that the channel is transporting sediment across the entire width of the channel during high flow events and is not developing depositional features

such as point bars on the inside of meander bends. Design plans indicate two of the three pool segments are designed with the same gently meandering radius of curvature as riffle segments (20 meters). This gently meandering channel planform geometry is not designed to generate deep scour pools and well developed point bars; and as such, pool habitats in the reconstructed channel segment are expected to be only slightly deeper than riffles over time. Based on the surveyed channel dimensions, planform geometry, and the overall design slope of 0.47%, the reconstructed channel segment is expected to transport sediment through the project reach without developing significant depositional features. This sediment transport process is considered an improvement over pre-project conditions, which included a series of backwatered sloughs upstream of culverts installed beneath residential driveways. Continued monitoring at the established transect locations will document substrate deposition, pool scour, and whether the channel maintains lateral stability over time.

4.7. Longitudinal Profile Survey

The longitudinal profile of the channel thalweg reveals the presence of three distinct pool features within the project reach, further indicating the formation of variable habitat features. The upper extent of the project reach from STA 0+00 to 150+00 has a relatively constant slope indicative of a riffle feature. Riffles also exist between each of the pools.

4.8. Wildlife Documentation

Wildlife observations at the Bowser Creek Stream Mitigation site in 2013 and 2014 have been limited. Three bird species (American Robin, Mallards, and Sparrows) were observed during the 2014 monitoring event and a white-tailed deer was observed on site in 2013 (Table 7). The relative lack of wildlife use of the project reach may be attributed to the proximity with Highway 2, the time of day that the monitoring event took place (late afternoon in 2013), weather (heavy rain in 2014), lack of habitat, and high temperatures (in 2013).

Table 7. Wildlife observations at Bowser Creek stream mitigation site in 2013 and 2014.

Common Name	Scientific Name
American Robin	***Turdus migratorius***
Mallard	***Anas platyrhynchos***
Sparrow Sp.	***Passer sp.***
White-tailed Deer	*Odocoileus virginianus*

Observations made in 2014 are **bolded.**

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Bowser Creek stream mitigation site is intended to document whether the reconstructed segment of the channel is meeting, or moving toward meeting the performance standards outlined in the monitoring plan. Results from the second year of monitoring suggests that all six quantitative performance standards are being met four

years following completion of the project (Table 8). Channel form success is considered a qualitative criterion, and is discussed in more detail in Section 5.4.

5.1. Riparian Buffer Success

The results in Table 1 indicate the reconstructed segment of Bowser Creek is densely revegetating, and primarily consists of herbaceous vegetation along the riparian and stream bank zones. Woody riparian vegetation is also establishing; however, the small size of woody plantings is currently only capable of providing a relatively limited percent cover.

Vegetation monitoring of the riparian buffer and stream banks indicated 93% of disturbed areas had successfully revegetated with non-noxious weed species following construction. Desirable vegetative cover was determined by subtracting the percent of noxious weed species cover (7%) from the total vegetative cover for the site (100%). Performance criteria specify at least 50% of the disturbed areas within the creditable buffer area must be vegetated with non-weedy species; therefore, this criterion is currently being met. The performance criterion for noxious weeds (≤10%) is also currently being met at this project site.

Total combined areal vegetative cover of the riparian zone and both right and left stream banks along Bowser Creek is currently 100%. Both riparian and stream bank zones are heavily vegetated with woody and herbaceous species. The performance criterion for this category specifies ≥70% of the combined riparian and stream bank vegetation communities must have vegetative establishment; therefore, this criterion is currently being met.

Woody vegetation plantings survival percentage is 94% four years following construction. The performance criteria states 50% of the woody plants installed must survive five years following construction; therefore, one year of additional monitoring is necessary to meet this criterion. Woody plants remain relatively small but should provide increased percent cover of the site as they mature. Dense vegetation growth within the riparian corridor made locating smaller woody plantings difficult; however very few dead woody plantings were observed throughout the project site. Several large 15-foot tall paper birch trees installed at the top of the north embankment did not survive, potentially due to their elevation above the water table. Smaller woody shrubs installed throughout the riparian corridor showed excellent survival.

Table 8. Performance standards for the Bowser Creek Stream Mitigation Site.

Type	Parameter	Performance Standard	Status	Site Meeting Performance Criteria?
Performance Criteria	Riparian Buffer Success	1a. Areas within creditable riparian buffer disturbed during construction must have 50% or greater aerial cover of non-noxious weed species by the end of the monitoring period	Vegetation transects indicate **92%** cover of the riparian zones with non-noxious weed species	**YES**
		1b. Noxious weeds do not exceed 10% cover within the riparian buffer areas.	Vegetation transects indicate **7%** cover of noxious weeds within riparian zones , an increse from 2013.	**YES**
	Vegetation Success	2a. Combined aerial cover of riparian and stream bank vegetation communities is at least 70%	Combined aerial cover of riparian and stream bank vegetation is **93%**	**YES**
		2b. Planted trees and shrubs must exhibit 50% survival after 5 years	Planted tree and shrub survival documented at **94%.**	**YES**
	Vegetation along Streambanks	3. Majority of plants on the river bank must have root stability indexes of at least 6	Dominant species observed on banks is reed canary grass, with a root stability index of **9.**	**YES**
	Streambank Stability Success	4. Less than 25% of bank length is unstable and classified as eroding bank.	Observations noted **17%** of the stream banks are eroding or unstable.	**YES**
Qualitative Criteria	Channel Form	5. Will be achieved when the stream stabilizes, includes pools and riffles, allows for flood events to occupy the floodplain, and the habitat features such as riparian plant communities have successfully established along streambanks.	Evidence of channel form success provided in Section 5.4	**YES**

5.2. Vegetation Along Stream Banks

The most prevalent species observed along the banks was reed canary grass, which covered greater than 50% of the stream banks. Reed canary grass has a stability index of 9, indicating its ability to effectively resist erosion. Overall, 31% of the species observed along Bowser Creek's banks have stability scores ≥6.

5.3. Stream Bank Stability

The stream bank inventory identified four eroding banks totaling 149 feet, or 17% of the total project bank length of 878 feet. Although four eroding banks were observed within the project reach, the performance criteria of less than 25% of the project reach exhibiting signs of instability is currently being met at this site.

5.4. Channel Form Success

The reconstructed section of Bowser Creek appears to have largely stabilized following completion of the project, as evidenced by a relatively small percent (17%) of eroding banks and no vertical head cuts. A dense stand of vegetation has established along the stream banks and within the riparian corridor adjacent to the channel, and will help provide a natural resistance to erosive forces during future flood events.

Results of the perpendicular transect surveys indicate the channel currently exhibits variability in both channel width and depth, with three pools having developed within the project reach. The channel cross section shape appears to be relatively uniform, with no point bars or other depositional features noted. This cross sectional shape is often observed in channels similar to the reconstructed segment of Bowser Creek with relatively straight planform geometry, low sinuosity, and gently meandering planform. Based on the lack of backwatering or bar formation, sediment transport has been improved over pre-construction conditions. Continued monitoring at pool and riffle features will provide evidence if the channel maintains habitat variability, stability, and develops any depositional features at these monitoring locations over time.

The Bowser Creek channel has been designed to convey an estimated 2 year return interval discharge within the low flow channel. Discharges greater than the 2 year flow are able to access a floodplain approximately 14 feet wide with a design grade of 5% slope toward the channel. Beyond this floodplain, the floodway has been designed to convey up to a 100 year discharge without over-topping Highway 2.

Data and photos included in this monitoring report provide evidence of establishment of vegetation along Bowser Creek's banks and riparian corridor. To date, woody shrubs are establishing adjacent to the creek, and once they mature, will provide additional habitat components such as shade, cover, and woody debris to the channel.

Based on the results of monitoring data collected to date, the modified segment of Bowser Creek is meeting all quantitative performance targets established in the monitoring plan for the site. Thus far, the project has met the objectives of a) constructing 430 linear feet of new channel; b) laying back floodplain slopes adjacent to

the channel from 1.5:1 to 4:1 slope or flatter; and c) implementing an aggressive revegetation plan to re-establish native riparian and upland vegetation. These results indicate the project is meeting the goal of providing compensatory mitigation for stream impacts associated with the U.S. Highway 2 widening segment of the Kalispell Bypass in the Missoula District four years following construction. One additional year of monitoring is required prior to final determination as to whether the on-site mitigation actions taken along Bowser Creek meet all compensatory mitigation performance requirements.

6.0 MANAGEMENT AND DESIGN RECOMMENDATIONS

6.1. Weed Management

Noxious weeds were observed in approximately 7% of the Bowser Creek project area. Weeds are dispersed sporadically on both banks within the project area and are illustrated on Figure 4 in Appendix A. The documentation of noxious weeds provided in this monitoring report allow for MDT to develop management plans for controlling noxious weeds along the reconstructed segment of Bowser Creek.

6.2. Use of Reference Data to Document Successful Pool Formation

The reconstructed segment of Bowser Creek has been designed with a low sinuosity and very broadly sweeping meanders. The ability of this channel segment to maintain long term pool habitat may be limited by the relatively straight planform geometry and prescribed radius of curvatures. However, assessment of the ability of Bowser Creek to successfully generate pool habitat should take into account the creek's natural ability to do so. In order to determine whether Bowser Creek is successfully providing adequate pool habitats, survey results from the reconstructed pool segments should be compared against appropriate reference reach pool data. If the reference reach data suggests a relatively straight planform alignment is appropriate, development of deep pools will be naturally limited. Collection of reference reach data, whenever available, is suggested for use in developing more specific success criteria pertaining to pool development on future stream mitigation projects.

Reference reach data may not always be available; as was the case for this reconstructed segment of Bowser Creek. Much of the Bowser Creek corridor has been developed and modified by highway and residential development. As a result, the design of the Bowser Creek incorporated discharges observed in Bower Creek and channel dimensions for similarly sized watersheds.

6.3. Floodplain and Riparian Development

Side slope designs along Bowser Creek provide room for a very narrow, 14 foot wide riparian and floodplain zone. Perpendicular transect survey results (Appendix B) illustrate a narrow bankfull bench adjacent to the creek has been constructed for flood inundation and wetland/riparian vegetation establishment. Integrating a slightly steeper upland side slope design would provide for a wider, more functional floodplain and

riparian zone by allowing the stream to access a larger, flat zone adjacent to the active channel (Figure 2). Constructing steeper side slopes and a wider floodplain area requires additional excavation; therefore a cost/benefit analysis of creating additional floodplain and wetland features, and the associated mitigation credits, is potentially worth consideration for future stream and riparian mitigation designs. Design of steeper side slopes also must take into consideration highway safety, and allow for vehicles to exit the roadway safely; therefore this design parameter may not allow for maximizing floodplain area adjacent to the channel.

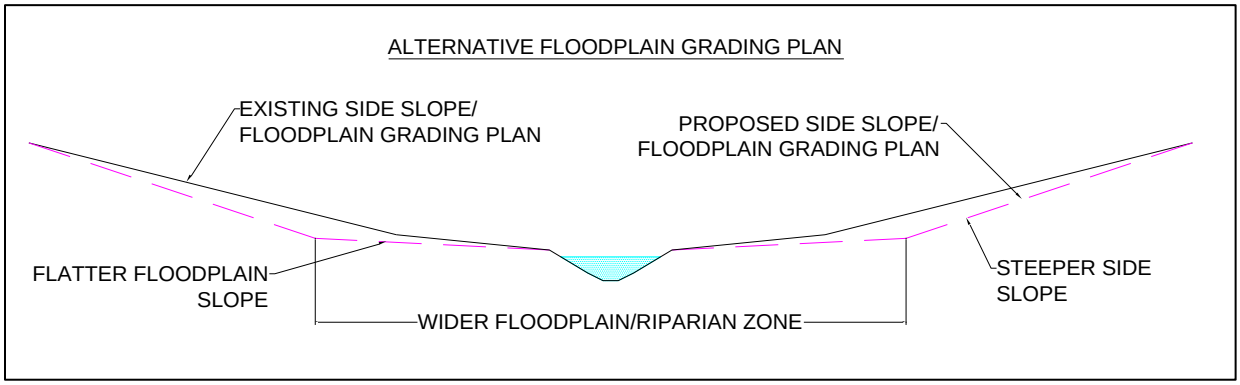


Figure 2. Alternative grading plan to increase floodplain and riparian areas.

6.4. Riparian Vegetation Zone

Design plans indicate riparian planting zones were only prescribed on the south side of Bowser Creek. Increasing the steepness of side slopes as illustrated Figure 2 would result in a wider riparian corridor, allowing for increased riparian vegetation establishment and the ecological benefits of such features along both sides of the channel. Consideration of this alternative grading plan is suggested for future stream mitigation projects.

6.5. Vegetation Success

The second monitoring event documented high survival rates of woody vegetation plantings. The majority of woody plants that did not survive were mature birch transplants installed along the north boundary of the project area near the top of the embankment. These trees appeared to die due to their lack of ability to reach the low water table. Mature willow transplants often have higher survival rates if the top 2/3 of the exposed branches are removed following installation. This technique focuses more energy toward production of roots during the first few years after installation. Overall, the planting techniques integrated on this project resulted in high survival success rates to date; it is therefore recommended future designs on similar stream and riparian corridors incorporate similar planting specifications.

7.0 LITERATURE CITED

Burton, T.A., S.J. Smith, and E.R. Cowley. 2011. Riparian area management: Multiple indicator monitoring (MIM) of stream channels and streamside vegetation. Technical

Reference 1737-23.BLM/OC/ST-10/003+1737. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO. 155 pp.

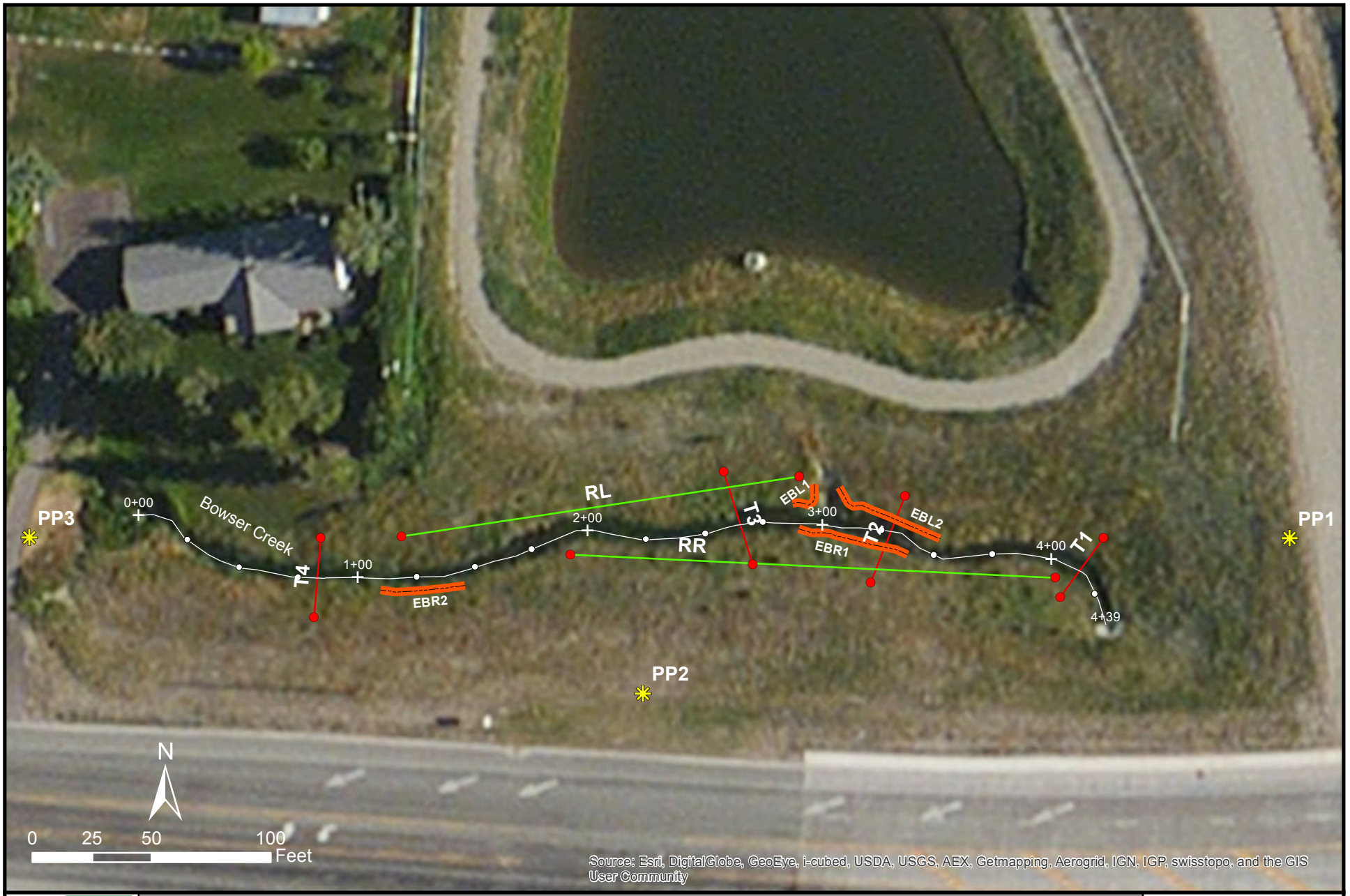
Montana Department of Transportation, 2008. Montana Wetland Assessment Method. Helena, Montana.

Winward, 2000. Monitoring the Vegetation Resources in Riparian Areas. Gen. Tech. Report RMRS-GTR.47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Appendix A

Project Site Maps

MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana



CONFLUENCE
consulting incorporated

Legend

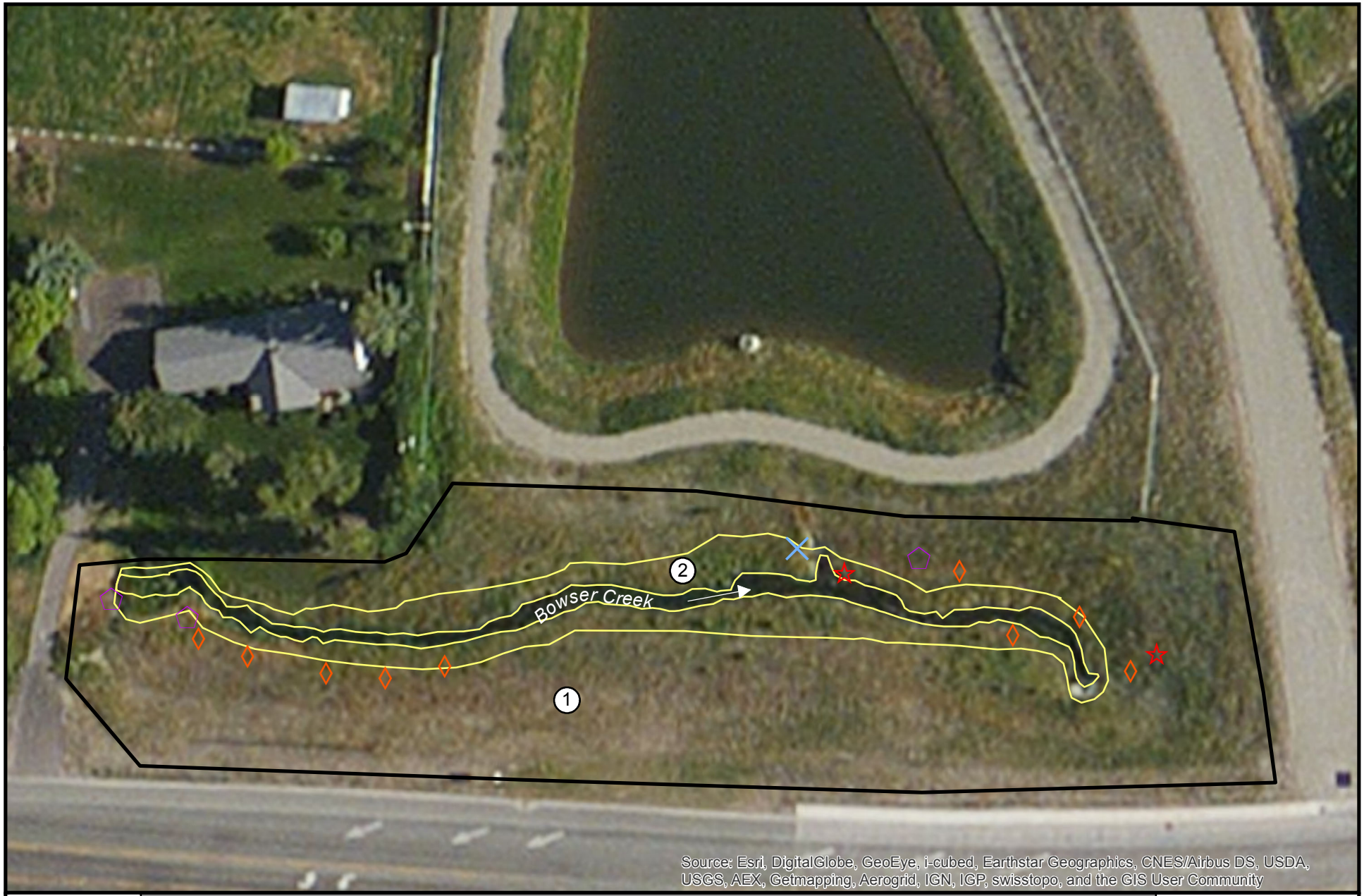
- Photo Points
- Riparian and Perpendicular Transect Endpoints
- Channel Thalweg
- Major Station (100')
- Minor Station (25')
- Eroding Banks
- Pool and Riffle Transects
- Riparian Transects

2014 Monitoring
Bowser Creek

Figure 3

Date: 09/16/2014

X:/MDT_.007/mains



CONFLUENCE
consulting incorporated

Legend

- Project Boundary
- Vegetation Community Boundary
- Centaurea stoebe
- Cirsium arvense
- Cynoglossum officinale
- Tanacetum vulgare
- 1 Elymus Community
- 2 Phalaris/Nasturtium Community

N

0 25 50 100 150 Feet

2014 Monitoring
Bowser Creek

Figure 4

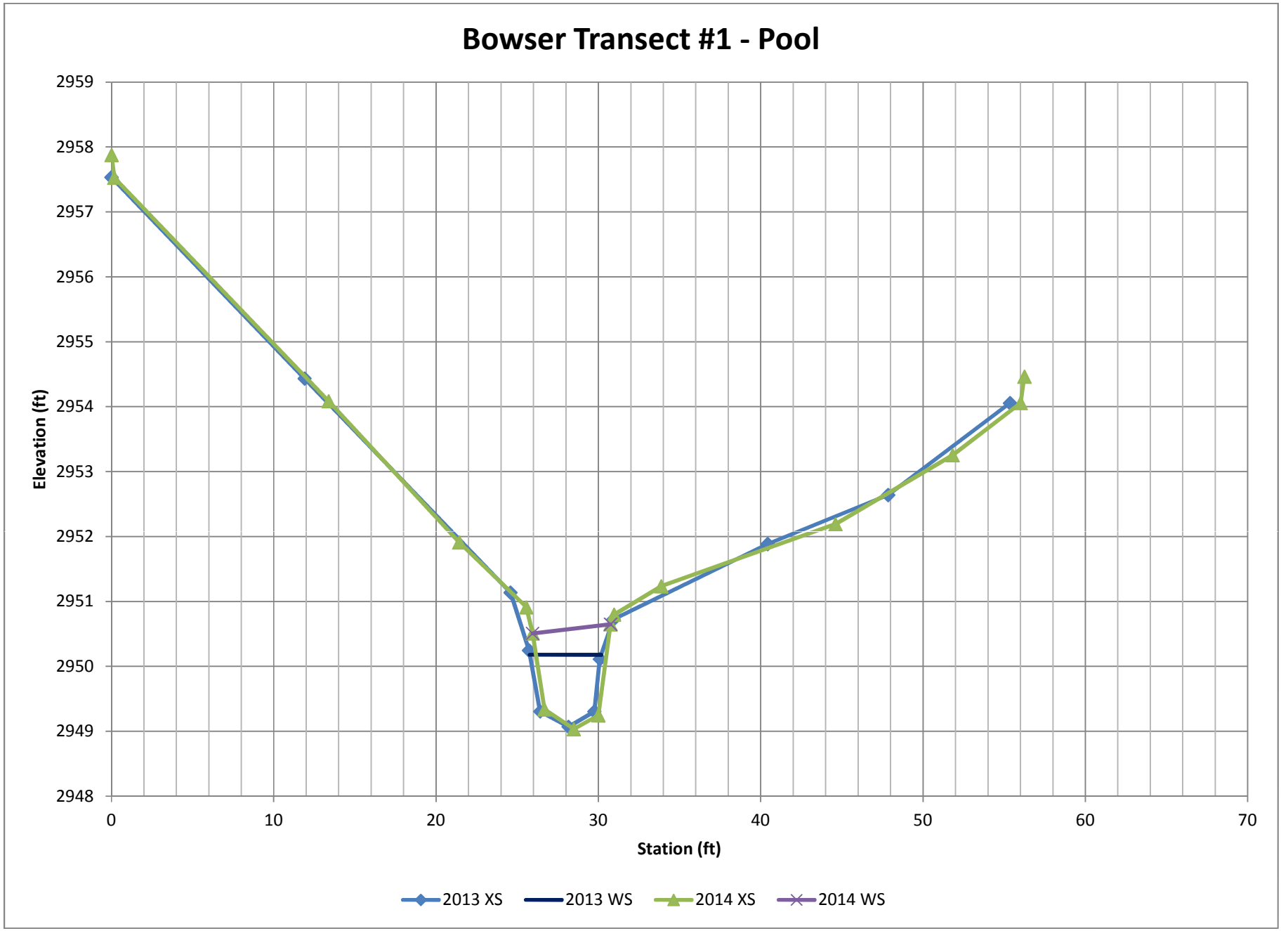
Date: 09/22/2014

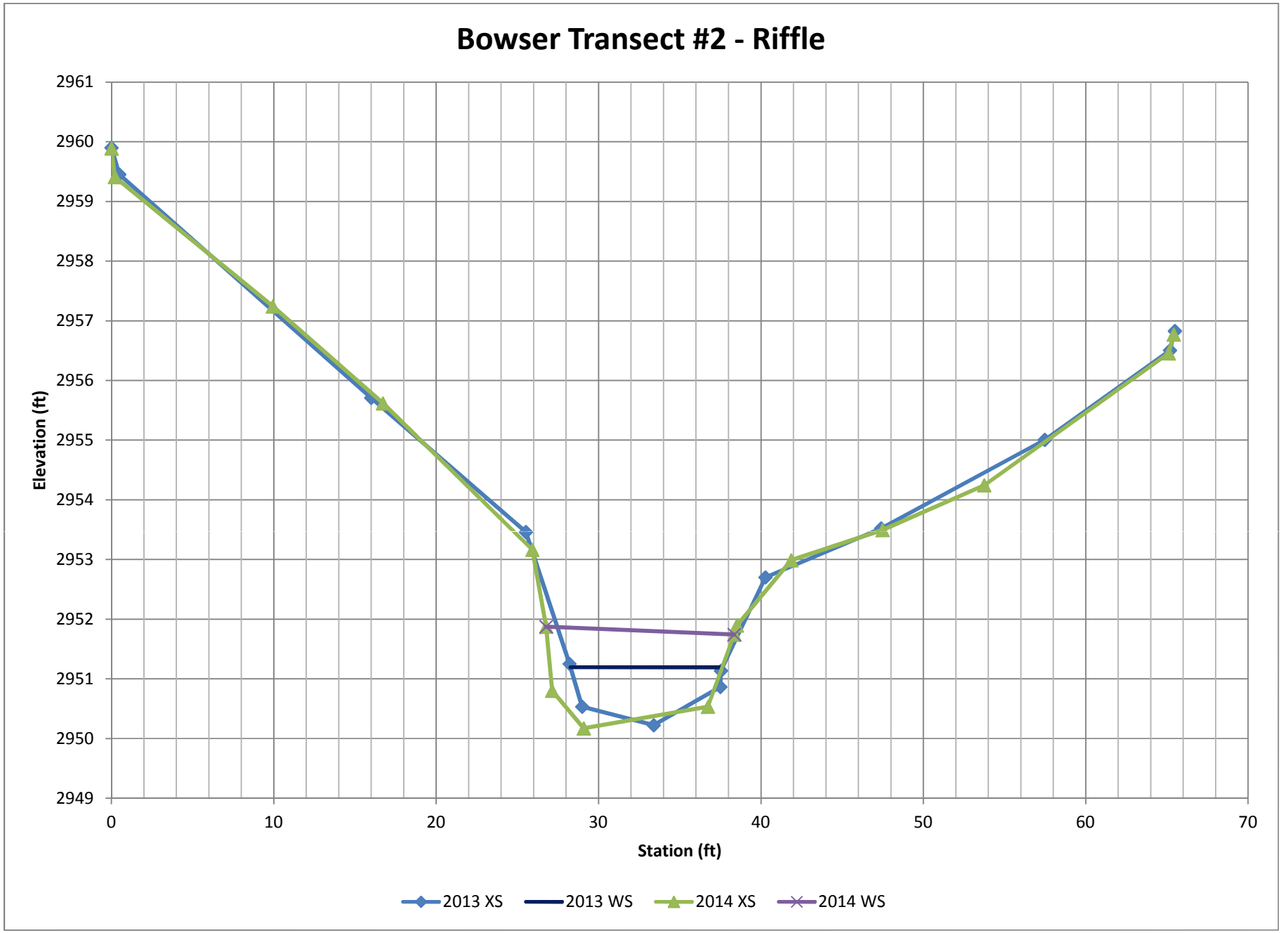
X:/MDT_.007/mains

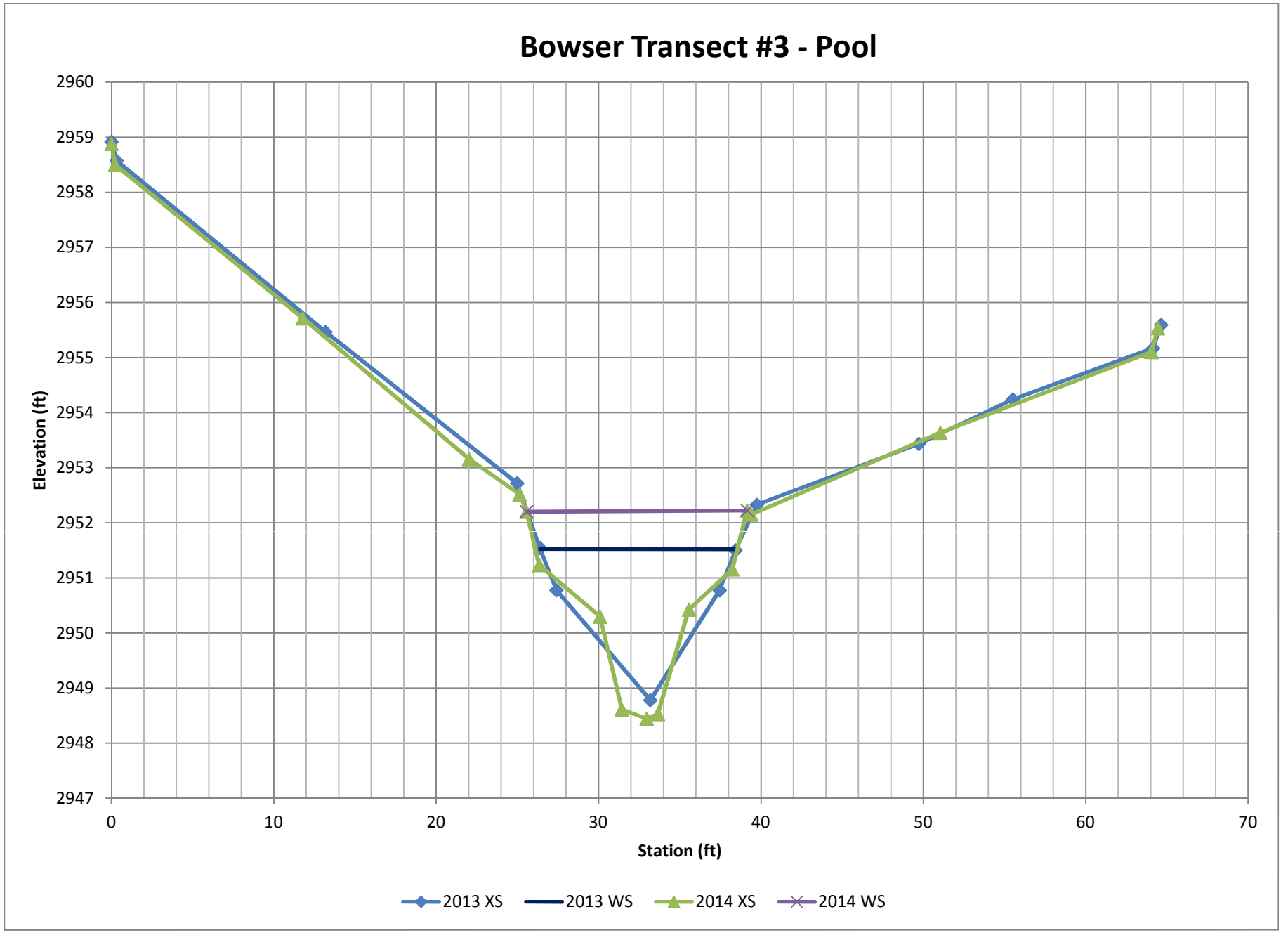
Appendix B

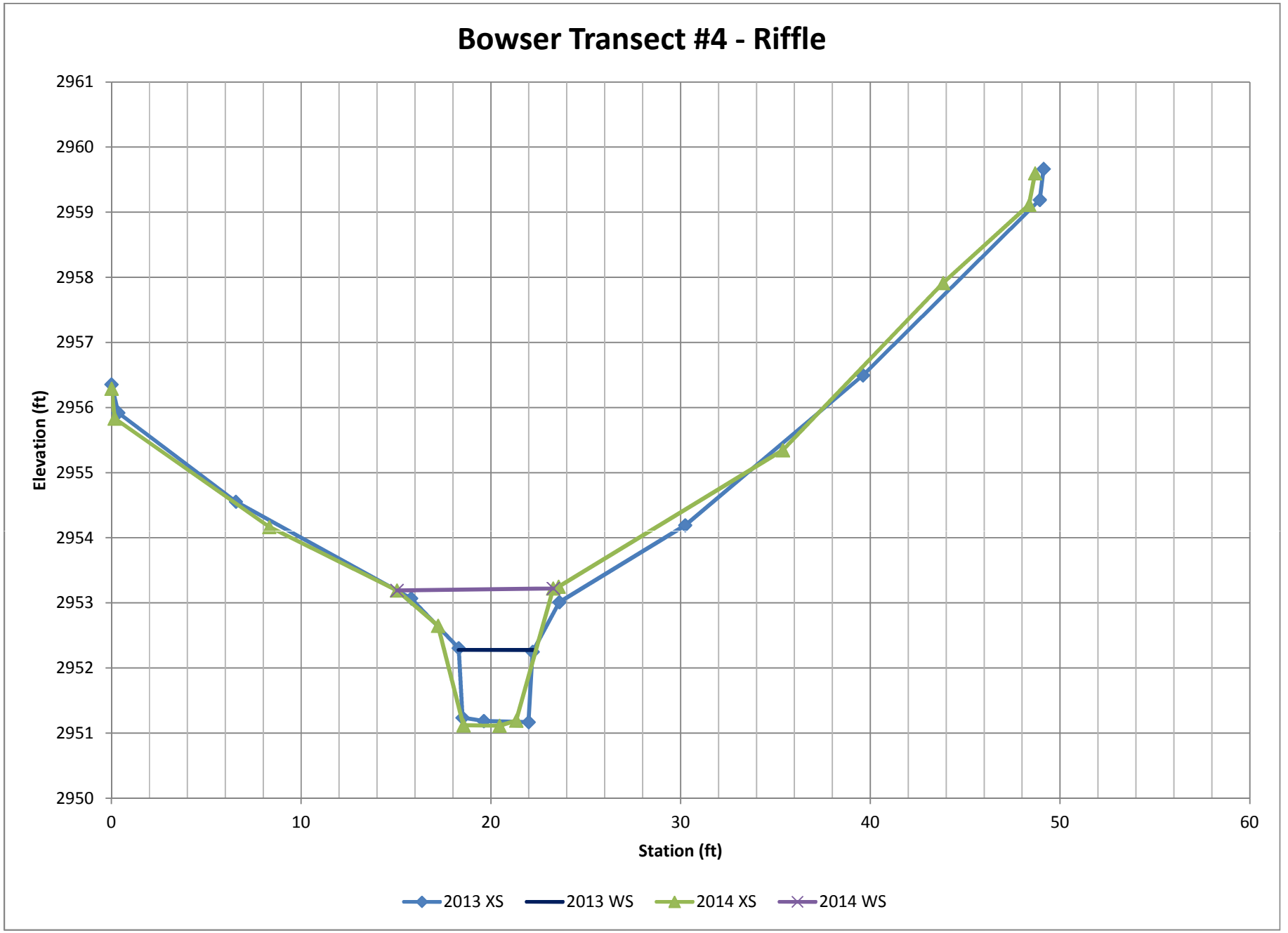
Perpendicular Transect Plots and Longitudinal Profile

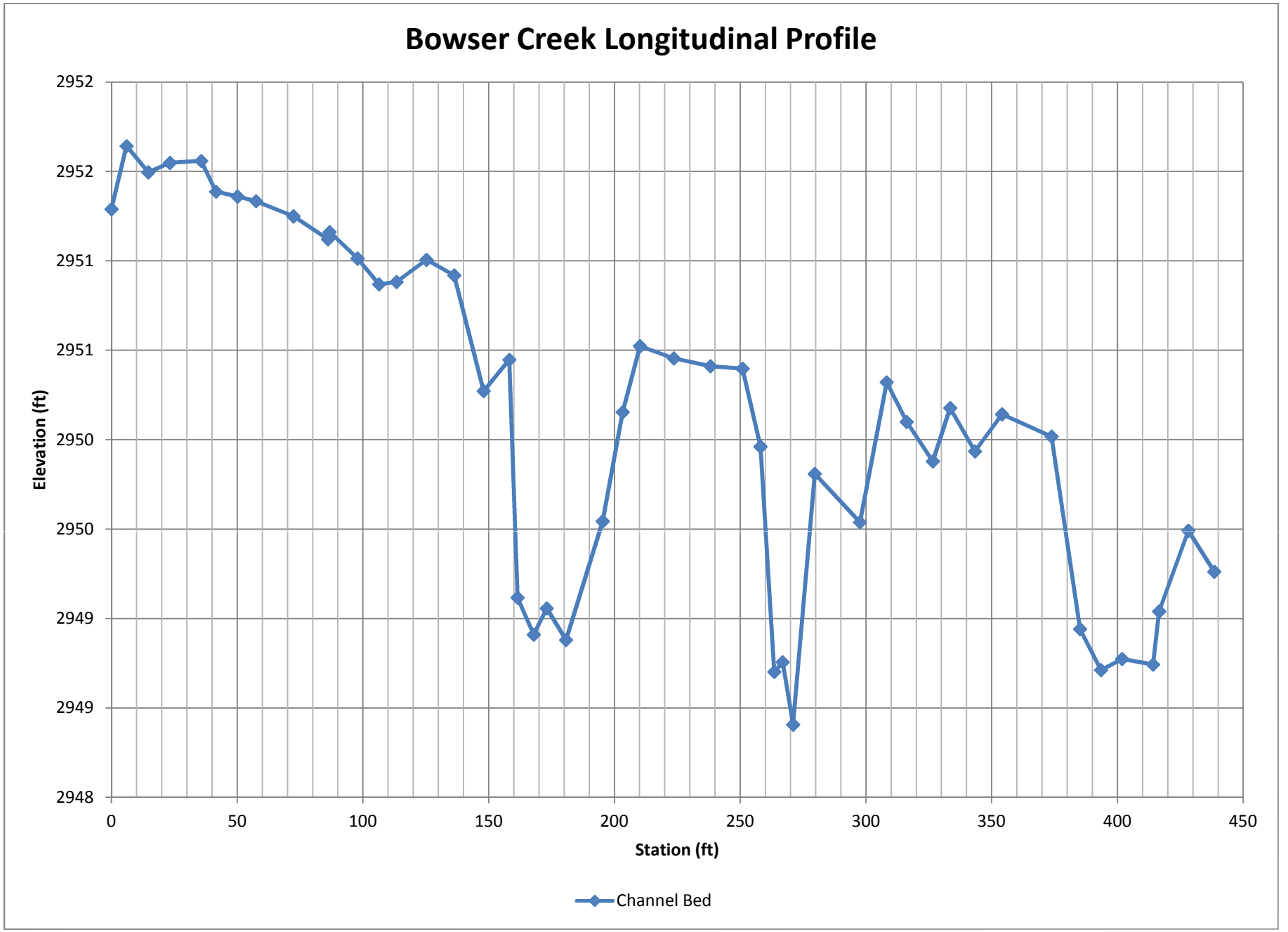
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana


Bowser Transect #1 - Pool
Elevation (ft)
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
2948
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS
2014 XS
2014 WS


Bowser Transect #2 - Riffle
Elevation (ft)
2961
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS
2014 XS
2014 WS


Bowser Transect #3 - Pool
Elevation (ft)
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
2949
2948
2947
0
10
20
30
40
50
60
70
Station (ft)
2013 XS
2013 WS
2014 XS
2014 WS


Bowser Transect #4 - Riffle
Elevation (ft)
2961
2960
2959
2958
2957
2956
2955
2954
2953
2952
2951
2950
0
10
20
30
40
50
60
Station (ft)
2013 XS
2013 WS
2014 XS
2014 WS


Bowser Creek Longitudinal Profile
Elevation (ft)
2952
2952
2951
2951
2950
2950
2949
2949
2948
0
50
100
150
200
250
300
350
400
450
Station (ft)
Channel Bed

Appendix C

Project Area Photos

MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events

CONFLUENCE

Photo Point 1—2013
Description: View looking west (upstream) of Bowser Creek. **Compass**: 270 (West)

Photo Point 1—2014
Description: View looking west (upstream) of Bowser Creek. **Compass**: 270 (West)

Photo Point 2.1—2013
Description: View looking northwest at Bowser Creek. **Compass**: 315 (Northwest)

Photo Point 2.1—2014
Description: View looking northwest at Bowser Creek. **Compass**: 315 (Northwest)

Photo Point 2.2—2013
Description: View across Bowser Creek looking north. **Compass**: 0 (North)

Photo Point 2.2—2014
Description: View across Bowser Creek looking north. **Compass**: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events

Photo Point 2.3—2013
Description: View looking northeast across Bowser Creek. **Compass**: 45 (Northeast)

Photo Point 2.3—2014
Description: View looking northeast across Bowser Creek. **Compass**: 45 (Northeast)

Photo Point 2.4—2013
Description: View looking east across Bowser Creek. from photo point 2. **Compass**: 90 (East)

Photo Point 2.4—2014
Description: View looking east across Bowser Creek. from photo point 2. **Compass**: 90 (East)

Photo Point 3.1—2013
Description: View looking east (downstream) of Bowser Creek from photo point 3. **Compass**: 90 (East)

Photo Point 3.1—2014
Description: View looking east (downstream) of Bowser Creek from photo point 3. **Compass**: 90 (East)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events

CONFLUENCE

Photo Point 3.2—2013
Description: Downstream view of Bowser Creek channel from photo point 3. **Compass**: 90 (East)

Photo Point 3.2—2014
Description: Downstream view of Bowser Creek channel from photo point 3. **Compass**: 90 (East)

Photo 1—2013
Description: Instream vegetation on Bowser Creek.
Compass: 90 (East)

Photo 1—2014
Description: Instream vegetation on Bowser Creek.
Compass: 90 (East)

Photo 2—2013
Description: View across Bowser Creek of culvert on north side of channel. **Compass**: 0 (North)

Photo 2—2014
Description: View across Bowser Creek of culvert on north side of channel. **Compass**: 0 (North)

PHOTO INFORMATION

PROJECT NAME: Bowser Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events

CONFLUENCE

Photo 3
EBL1– Upstream of culvert, stream bank eroding for approximately 17 feet.

Photo 4
EBL2– Downstream of culvert, stream bank eroding for approximately 36 feet.

Photo 5
EBL2– Downstream of culvert, stream bank eroding for approximately 36 feet.

Photo 6
EBR1– Across from inflow culvert. Stream bank length is approximately 48 feet long, receding 2-3 feet.

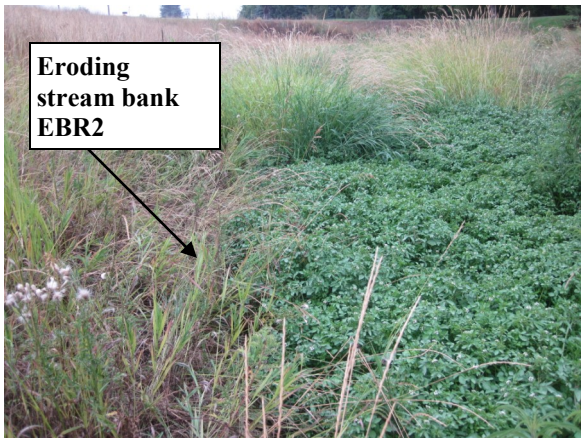


Photo 8
EBR2– Downstream of culvert, stream bank eroding for approximately 36 feet.

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

END OF PROJECT LOOKING DOWNSTREAM

END OF PROJECT LOOKING DOWNSTREAM

T1 LEFT: LOOKING SOUTHWEST TO T1 RIGHT

T1 RIGHT: LOOKING NORTHEAST TO T1 LEFT

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T1 LEFT: LOOKING WEST UPSTREAM

T1 LEFT: LOOKING SOUTH DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T1: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T1: LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T1 RIGHT: LOOKING WEST UPSTREAM

T1 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T2 LEFT: LOOKING SOUTH TO T2 RIGHT

T2 RIGHT: LOOKING NORTH TO T2 LEFT

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T2 LEFT: LOOKING WEST UPSTREAM

T2 LEFT: LOOKING SOUTHEAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T2: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T2: LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T2 RIGHT: LOOKING WEST UPSTREAM

T2 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T3 LEFT: LOOKING SOUTH TO T3 RIGHT

T3 RIGHT: LOOKING NORTH TO T3 LEFT

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T3 LEFT: LOOKING WEST UPSTREAM

T3 LEFT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T3: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T3: LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T3 RIGHT: LOOKING WEST UPSTREAM

T3 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T4 LEFT: LOOKING SOUTH TO T4 RIGHT

T4 RIGHT: LOOKING NORTH TO T4 LEFT

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T4 LEFT: LOOKING WEST UPSTREAM

T4 LEFT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T4: LOOKING WEST UPSTREAM FROM MIDDLE OF CREEK

T4: LOOKING EAST DOWNSTREAM FROM MIDDLE OF CREEK

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

T4 RIGHT: LOOKING WEST UPSTREAM

T4 RIGHT: LOOKING EAST DOWNSTREAM

PROJECT NAME: 2014 MDT STREAM MITIGATION—BOWSER CREEK

DATE: 7-29-14

WEST END OF PROJECT LOOKING EAST

WEST END OF PROJECT LOOKING EAST

Appendix D

Construction Plan Sheets

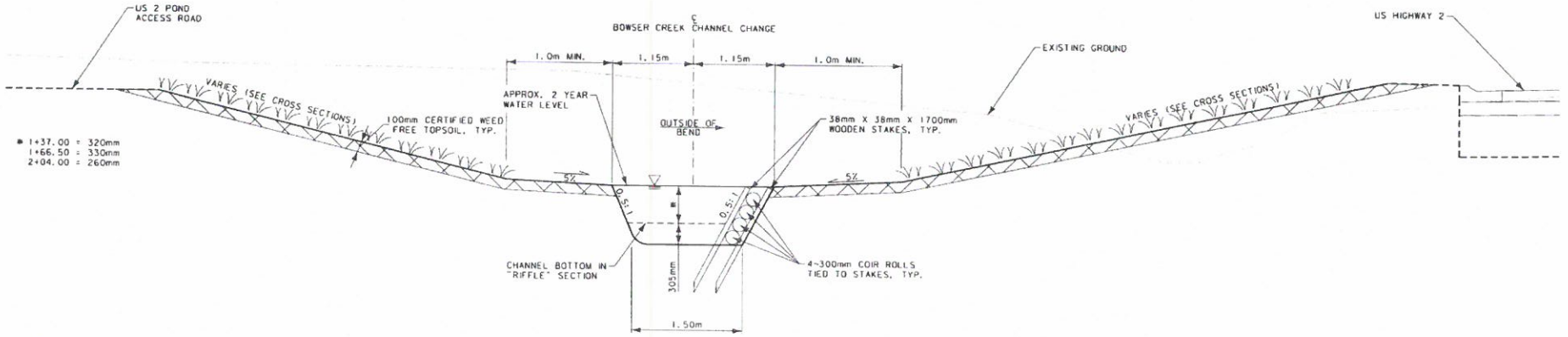
MDT Stream Mitigation Monitoring
Bowser Creek
Flathead County, Montana

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	39

CSF - 0.999470385

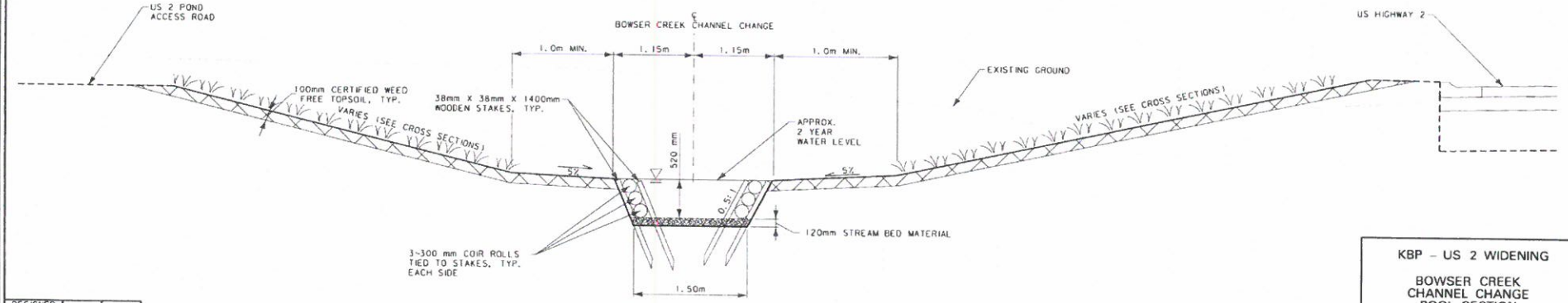
DETAIL

BOWSER CREEK CHANNEL CHANGE POOL SECTION



NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

BOWSER CREEK CHANNEL CHANGE RIFFLE SECTION



NOTE: SEE VEGETATION PLANS FOR SEEDING & PLANTINGS

KBP - US 2 WIDENING

BOWSER CREEK CHANNEL CHANGE POOL SECTION RIFFLE SECTION

NO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stelling Engineers, INC.

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	40

CSF- 0.999470385

DETAIL

BOWSER CREEK CHANNEL CHANGE

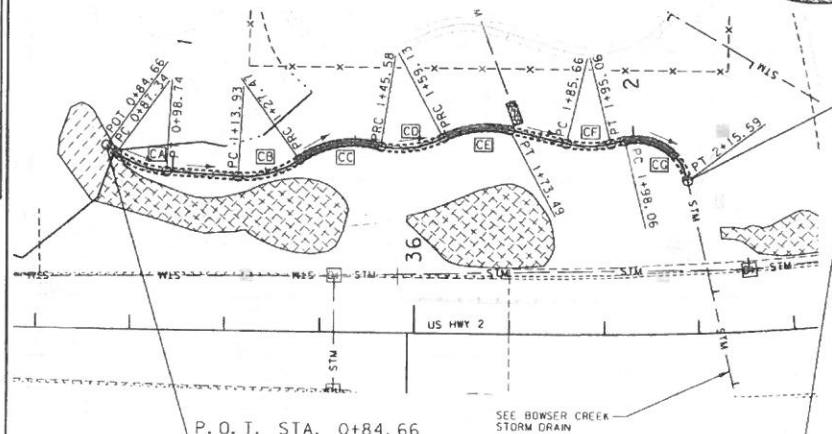
SPRING CREEK CHANNEL CHANGE CURVE DATA

CURVE	P.I.	Δ	RADIUS (m)	T	L	E	BACK TANGENT	AHEAD TANGENT
CA	0+93.20	32° 39' 20" LT	20.00	5.86	11.40	0.84	S 50° 45' 07" E	S 83° 24' 28" E
CB	1+20.97	38° 48' 07" LT	20.00	7.04	13.54	1.20	S 83° 24' 28" E	N 57° 47' 25" E
CC	1+37.20	51° 53' 00" RT	20.00	9.73	18.11	2.24	N 57° 47' 25" E	S 70° 19' 35" E
CD	1+52.63	38° 48' 35" LT	20.00	7.04	13.55	1.20	S 75° 55' 20" E	N 65° 16' 06" E
CE	1+66.63	41° 08' 10" RT	20.00	7.50	14.36	1.36	N 65° 16' 06" E	S 73° 35' 44" E
CF	1+90.45	26° 56' 29" LT	20.00	4.79	9.40	0.57	S 73° 35' 44" E	N 79° 27' 47" E
CG	2+09.31	91° 18' 24" RT	11.00	11.25	17.53	4.74	N 79° 27' 47" E	S 9° 13' 48" E

LEGEND

STREAM RIFFLE SECTION

STREAM POOL SECTION

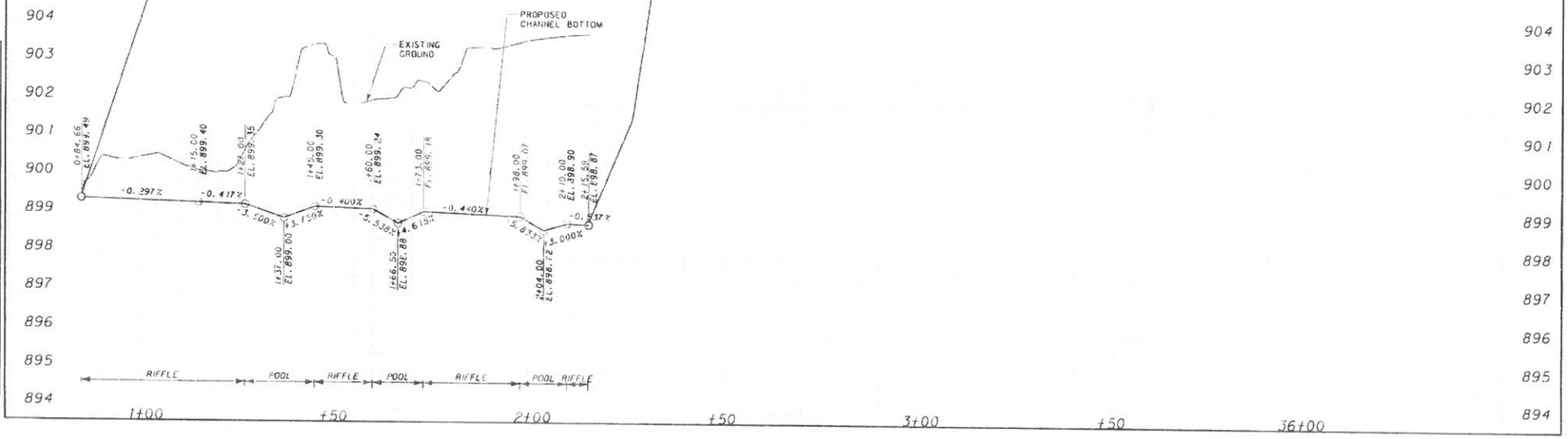


P.O.T. STA. 0+84.66
BEGIN BOWSER CREEK CHANNEL CHANGE =
STA. 35+34.77 US 2

P.O.T. STA. 2+15.59
END BOWSER CREEK CHANNEL CHANGE=
STA. 36+56.67 US 2

CENTERLINE COORDINATE TABLE

STATION	DESCRIPTION	N OR Y COORDINATE	E OR X COORDINATE	REMARKS
0+84.66	POT	449 740.9132	240 357.7066	BEGIN CHANNEL CHANGE
0+87.34	PC	449 739.2154	240 359.7848	
0+93.20	PI	449 735.5085	240 364.3220	
0+98.74	PT	449 734.8359	240 370.1422	
1+13.93	PC	449 733.0927	240 385.2258	
1+20.97	PI	449 732.2841	240 392.2228	
1+27.47	PRC	449 736.0384	240 398.1823	
1+37.20	PI	449 741.2244	240 406.4145	
1+45.58	PRC	449 737.9489	240 415.5760	
1+52.63	PI	449 736.2352	240 422.4094	
1+59.13	PRC	449 739.1827	240 428.8082	
1+66.63	PI	449 742.3225	240 435.6246	
1+73.49	PT	449 740.2030	240 442.8239	
1+85.66	PC	449 736.7665	240 454.4968	
1+90.45	PI	449 735.4135	240 459.0926	
1+95.06	PT	449 736.2896	240 463.8025	
1+98.06	PC	449 736.8382	240 466.7522	
2+09.31	PI	449 738.8962	240 477.8162	
2+15.59	PT	449 727.7881	240 479.6213	END CHANNEL CHANGE



MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

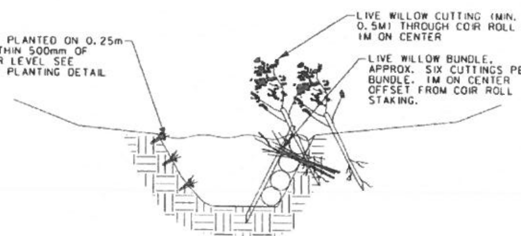
Stelling Engineers, INC.

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V1

CSF = 0.999470385

DETAIL

TABLE OF CONTENTS & DETAILS



ZONE D COIR BUNDLES WITH WILLOW CUTTINGS AND LAYERING
SCALE: NOT TO SCALE

HARVESTING AND INSTALLATION NOTE:

1. HARVEST AND PLANT CUTTINGS DURING DORMANT SEASON.
2. USE HEALTHY STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE CUTTINGS OR SPLIT ENDS DURING INSTALLATTION.
4. BRIEFLY SOAK CUTTINGS IN WATER AND ROOTING HORMONE PRIOR TO INSTALLATION.
5. FOR LAYERING, BUNDLE 6 CUTTINGS TOGETHER AND BIND WITH BIODEGRADABLE JUTE STRING.
6. INSTALL WILLOW CUTTING AND WILLOW BUNDLE LAYERING DURING BANK GRADING AND COIR PLACEMENT.
7. WILLOW CUTTING AND WILLOW BUNDLES SHALL EXTEND INTO EXPECTED MOISTURE SOIL ZONES.
8. IF NECESSARY, CUT SMALL HOLES IN COIR ROLLS AND INSERT LIVE WILLOW CUTTING.
9. INSERT BUNDLES INTO SOIL BETWEEN COIR ROLLS.

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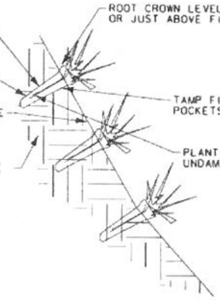
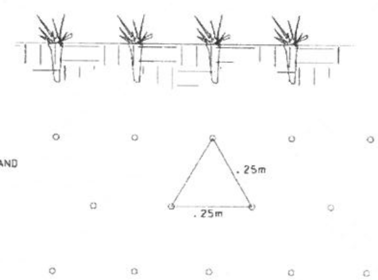
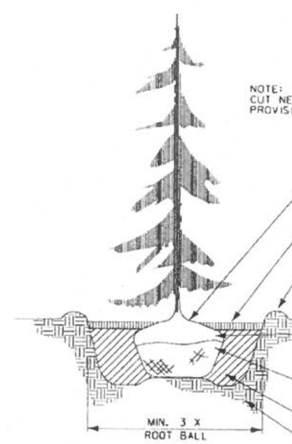


ZONE D RIPARIAN PLUG PLANTING
FOR INSIDE BEND OF SPRING CREEK POOLS
SCALE: NOT TO SCALE



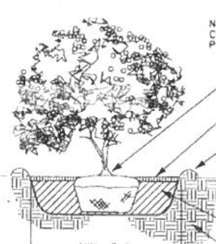
SPACING

NOTE: PLACE JUTE NETTING ON SLOPES GREATER THAN 33%. CUT NETTING TO ACCOMODATE PLANTINGS. SEE SPECIAL PROVISIONS FOR JUTE SPECIFICATION.



TREE PLANTING
SCALE: NOT TO SCALE

NOTE: PLACE JUTE NETTING ON SLOPES GREATER THAN 33%. CUT NETTING TO ACCOMODATE PLANTINGS. SEE SPECIAL PROVISIONS FOR JUTE SPECIFICATION.



SHRUB PLANTING
SCALE: NOT TO SCALE

DESIGNER		
DRAWN		
APPROVED		
REVISED		
	INITIALS	DATE

KBP - US 2 WIDENING

TABLE OF CONTENTS & DETAILS

NO SCALE

MDT MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stelling Engineers, INC.

DESIGNED BY
REVIEWED BY
CHECKED BY

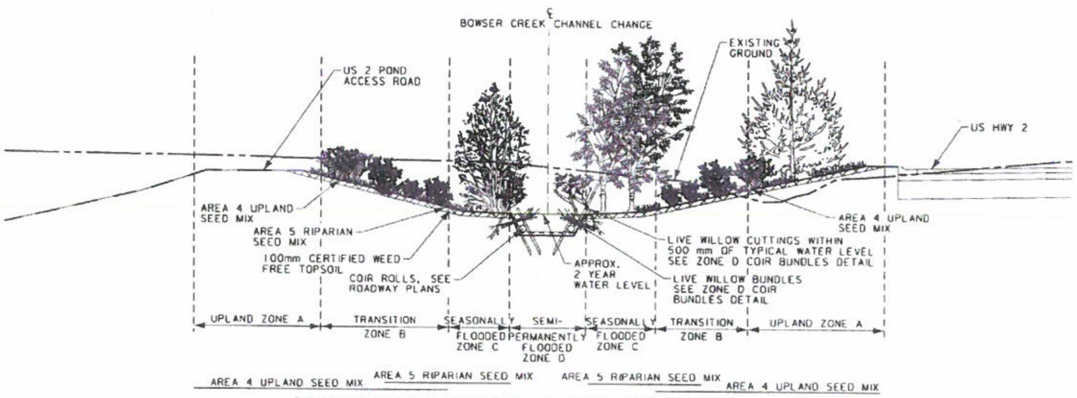
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V2

CSF = 0.999470385

DETAIL

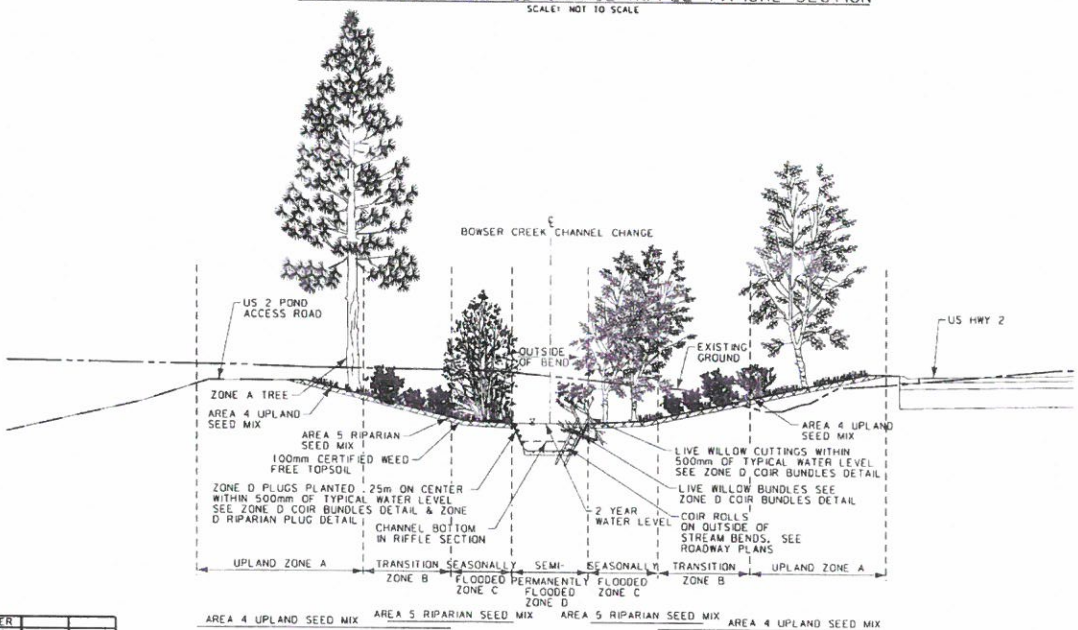
BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY

NOTES:
1. SEE ROADWAY PLANS FOR CHANNEL CONSTRUCTION DETAILS.
2. TYPICAL SECTIONS ARE GENERAL CONCEPTUAL DESIGN. FOR INFORMATION ONLY



BOWSER CREEK CHANNEL CHANGE RIFFLE TYPICAL SECTION

SCALE: NOT TO SCALE



BOWSER CREEK CHANNEL CHANGE POOL TYPICAL SECTION

SCALE: NOT TO SCALE

CHANNEL PLANTING SEQUENCE

1. PLACE COIR ROLL AS PER COIR ROLLS DETAIL IN ROADWAY PLANS AND SPECIAL PROVISIONS.
2. INSTALL PLANTS BETWEEN THE DATES OF OCTOBER 1 AND MAY 15 PROVIDED THE GROUND IS NOT FROZEN.
3. PLANT RIPARIAN PLUGS AS PER PLANTING DETAIL.
4. PLANT WILLOW CUTTINGS AND BUNDLES AS PER PLANTING DETAIL.
5. INSTALL JUTE NETTING ON SLOPES GREATER THAN 3:1 AS PER SPECIAL PROVISIONS.
6. SEED UPLAND AREA 4 AND RIPARIAN AREA 5 AS PER SEEDING SPECIAL PROVISIONS.
7. PLANT TREES AND SHRUBS AS PER PLANTING DETAILS.
8. APPLY MYCORRHIZAL FUNGI AS PER SPECIAL PROVISIONS.
9. APPLY WEED FREE ORGANIC COMPOST MULCH AS PER SPECIAL PROVISIONS.

BOWSER CREEK CHANNEL CHANGE PLANT LIST *

TYPE	BOTANICAL NAME	COMMON NAME	QNTY	SIZE
ZONE A UPLAND				
TREES				
BP	BETULA PAPYRIFERA	PAPER BIRCH	6	10' B&B
PP	PINUS PONDEROSA	PONDEROSA PINE	1	7' B&B
ZONE B TRANSITIONAL				
SHRUBS				
Ag	AMELANCHIER ALNIFOLIA	SASKATOON SERVICEBERRY	124	1 GAL.
Pv	PRUNUS VIRGINIANA	COMMON CHOKECHERRY	7	5 GAL.
Rw	ROSA WOODSII	WOODS ROSE	177	1 GAL.
Sc	SHEPHERDIA CANADENSIS	CANADA BUFFALOBERRY	27	1 GAL.
So	SYMPHORICARPOS ALBUS	SNOWBERRY	57	1 GAL.
ZONE C SEASONALLY FLOODED				
TREES				
BO	BETULA OCCIDENTALIS	WATER BIRCH - MUTLISTEM	5	15 GAL.
SHRUBS				
At	ALNUS INCANA SSP. TENUIFOLIA	THIN-LEAF ALDER	21	5 GAL.
Cs	CORNUS STOLONIFERA/SERICEA	RED-OSIER DOGWOOD	40	1 GAL.
Sb	SALIX BEBBIANA	BEBB WILLOW	18	5 GAL.
Sd	SALIX DRUMMONDIANA	DRUMMOND WILLOW	22	5 GAL.
ZONE D SEMI-PERMANENTLY FLOODED				
COIR ROLL STAKING SPACE @ 1m ON CENTER				
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	222	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	222	CUTTINGS
COIR ROLL LAYERING SPACE 6 CUTTINGS PER BUNDLE @ 1m ON CENTER				
Sb	SALIX DRUMMONDIANA	DRUMMOND WILLOW	666	CUTTINGS
Sb	SALIX EXIGUA	SANDBAR WILLOW	666	CUTTINGS
STREAMBANK PLUGS				
	CAREX NEBRASCENSIS	NEBRASKA SEDGE	120	PLUGS
	CAREX UTRICULATA	BEAKED SEDGE	167	PLUGS
	CAREX VESICARIA	INFLATED SEDGE	120	PLUGS
	GLYCERIA ELATA (STRIATA)	FOWL MANNAGRASS	73	PLUGS

* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".

JUTE NETTING *

STATION FROM	STATION TO	square meters
35+34.77	36+58.67	200
TOTAL		200

* FOR INFORMATION ONLY. INCLUDE ALL COSTS AND INCIDENTAL ITEMS ASSOCIATED WITH THE INSTALLATION OF THIS ITEM IN THE LUMP SUM BID PRICE FOR "VEGETATION".

KBP – US 2 WIDENING

BOWSER CREEK VEGETATION TYPICAL SECTIONS & SUMMARY

NO SCALE

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MDT MONTANA DEPARTMENT OF TRANSPORTATION

MONTANA CADD

SE Stelling Engineers, Inc.

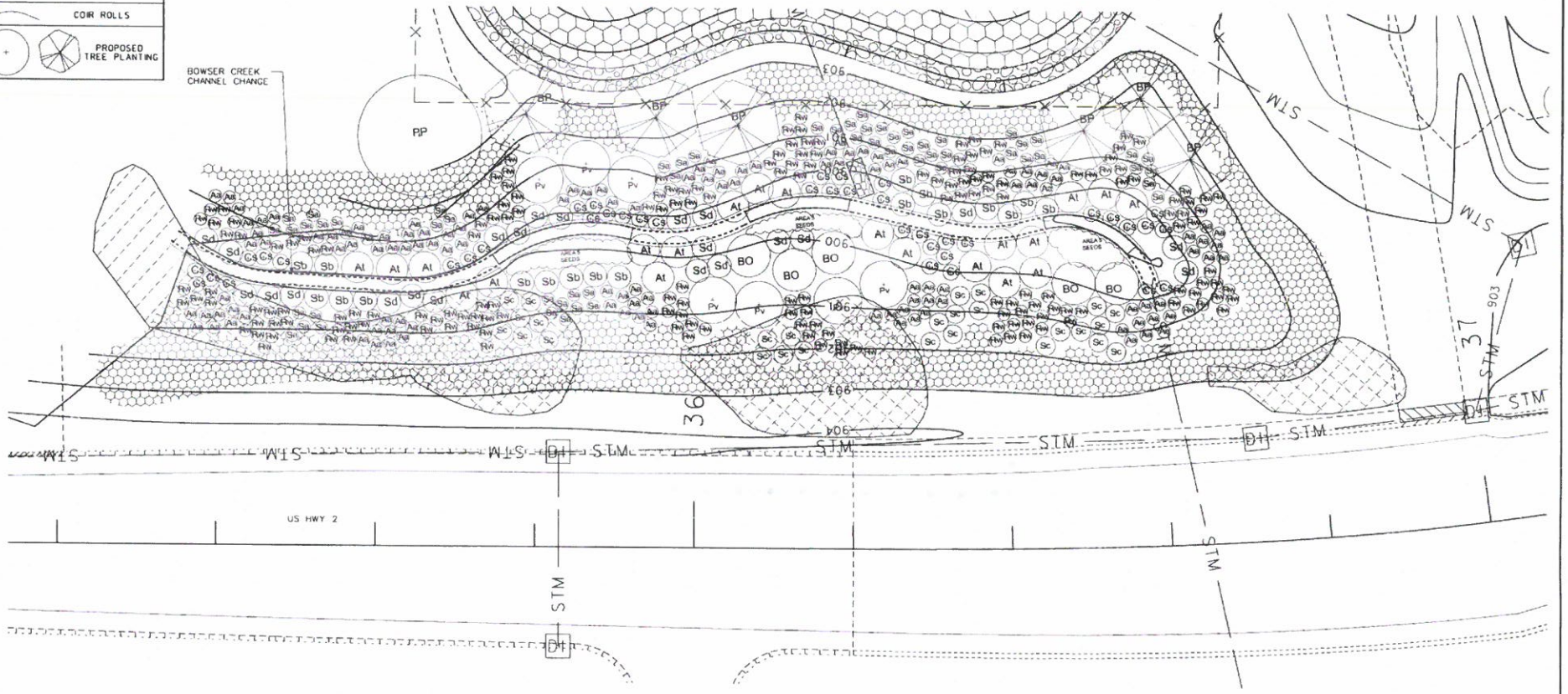
DETAIL

BOWSER CREEK
VEGETATION PLAN

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 15(93)	V3

CSF = 0.999470385

LEGEND
AREA 4 UPLAND SEED MIX
AREA 5 RIPARIAN SEED MIX
PROPOSED SHRUB PLANTING
COIR ROLLS
PROPOSED TREE PLANTING



NOTE: THIS PLAN IS A GRAPHIC REPRESENTATION. REFER TO SECTIONS AND PLANT LISTS FOR MORE DETAILED ZONAL PLACEMENT.

KBP – US 2 WIDENING

BOWSER CREEK
VEGETATION PLAN

SCALE = 1:250

	INITIALS	DATE
DESIGNER		
DRAWN		
APPROVED		
REVISED		

MONTANA DEPARTMENT OF TRANSPORTATION
MDT
MONTANA CADD
SE Stelling Engineers, INC.