MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT

Mill Creek
Ravalli County, Montana

Prepared for:

MONTANA DEPARTMENT OF TRANSPORTATION
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December 2013

MONTANA DEPARTMENT OF TRANSPORTATION

STREAM MITIGATION MONITORING REPORT:

YEAR 2013

Mill Creek
Granite County, Montana

MDT Project Number: NH7-(114)59
Control Number: 2015004

SPA Number: MDT-R2-15-2010
USACE Number: NOW-1997-90821-MTH

Prepared for:

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CCI Project No: MDT_.007

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Cover: Mill Creek channel upstream of U.S. Hwy 93

1.0 INTRODUCTION

As part of the construction of the Bear Creek Road-South segment of U.S. Highway 93, the Montana Department of Transportation (MDT) relocated a segment of Mill Creek to align with a new, permanent bridge. The realignment of Mill Creek included deactivating and filling approximately 630 feet of the channel and constructing approximately 581 feet of new channel through a relic flood swale. Permanent impacts to Mill Creek were authorized by the U.S. Army Corps of Engineers (USACE), as outlined in Corps permit number NWO-1997-90821-MTH and SPA 124 Authorization number MDT-R2-15-2010.

Special conditions specified in this permit included monitoring of the relocated segment of Mill Creek for five years following channel construction to determine streambank stability and the success of riparian vegetation establishment. Success criteria and monitoring requirements specified in the USACE permit include:

1. **Riparian coverage** - 80% aerial coverage with a minimum of 50% aerial coverage by woody species by the end of the third growing season.

2. **Streambank stability** - identification of any unstable streambanks within the relocated channel.

3. **As-built** - as built drawings of the relocated channel at a 1:50 scale or smaller and planting schematic with a planted species list and number of plants planted.

4. **Monitoring stations** - establishment of 4 monitoring stations 75' apart with surveyed cross sections and bank pins installed as permanent reference points.

5. **Photo points** - color photos at each monitoring station showing both banks and upstream and downstream views.

This report summarizes the results of the first year monitoring of the Mill Creek project including results of vegetation and bank erosion monitoring, a 2013 topographic survey of the project site, survey results at four perpendicular transects, a planting schematic from the approved design, photo-documentation of the project site, and a map indicating the endpoints of riparian belt transects and perpendicular transect surveys.

2.0 SITE LOCATION

This monitoring site is located in Section 19, Township 7 North, Range 20 West, in Ravalli County, Montana (Figure 1). Mill Creek flows beneath a newly constructed bridge on U.S. Highway 93 approximately 7 miles north of Hamilton. The project reach includes approximately 500 feet of Mill Creek upstream of the Highway 93 Bridge and extends approximately 100 feet downstream of the bridge. Note the topographic map in Figure 1 refers to Mill Creek as Fred Burr Creek below the confluence of these streams. The National Hydrography data set indicates the project area is on Fred Burr Creek.

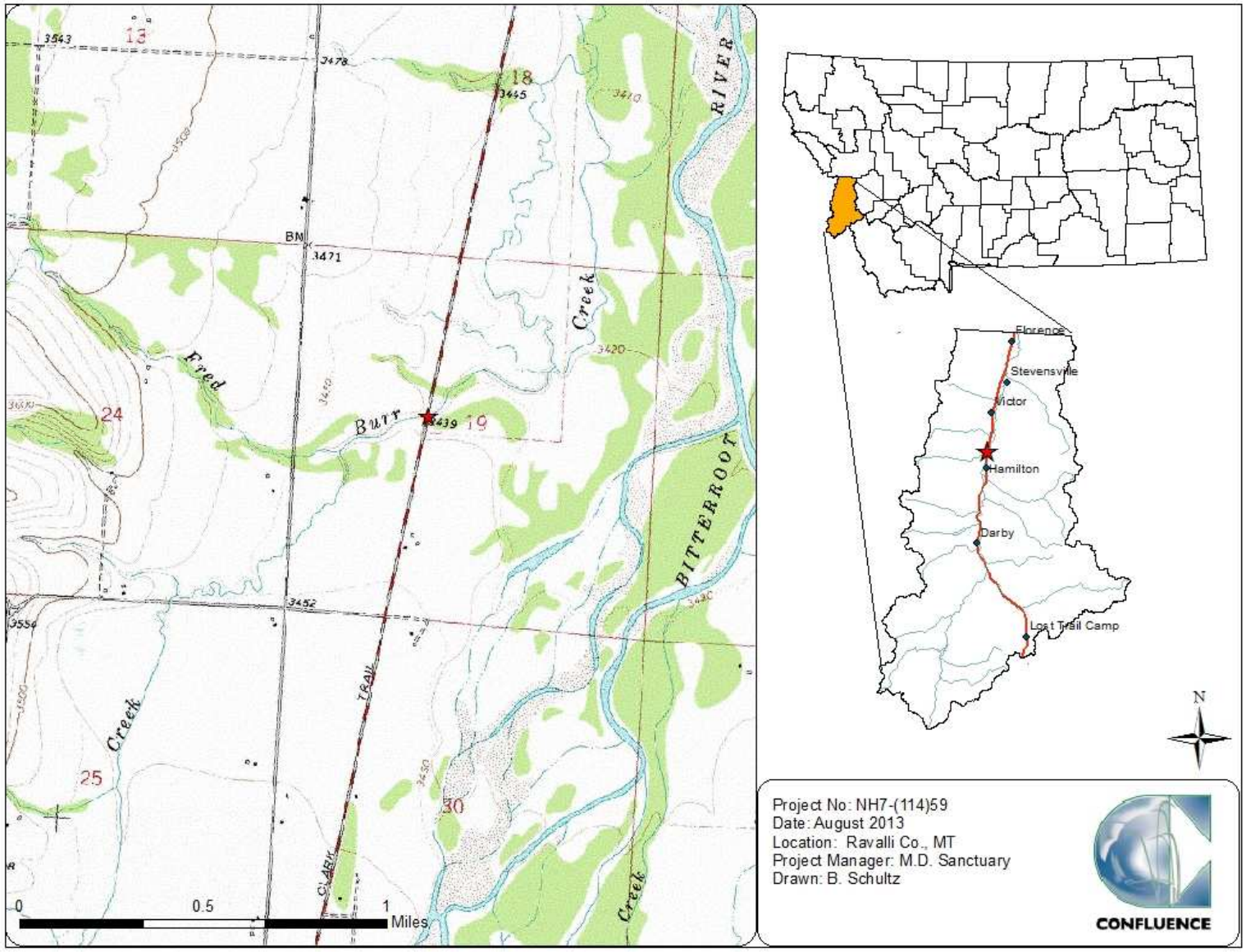


Figure 1. Project location of Mill Creek stream mitigation site.

3.0 MONITORING METHODS

Monitoring field crews visited the project site on July 25, 2013 while survey crews visited the site on August 28, 2013. The following data were collected at the Mill Creek stream mitigation site:

3.1. Riparian Vegetation Inventory - Belt Transects

Two riparian belt transects were established; one on each side of the stream channel. The belt transect on the right (south) bank is parallel to the downstream extent of the project reach for 140 feet. The left (north) bank belt transect doglegs to maintain a parallel alignment with the channel for 435 feet (Figure 2, Appendix A). GPS points were logged at riparian transect endpoints and corners with a Magellan Promark III GPS unit. Each endpoint or corner of the riparian transects were marked with t-posts or flagged trees to allow for relocation during subsequent monitoring events. Field data collection at each riparian transect included aerial percent cover of total vegetation, woody vegetation, and noxious weeds.

3.2. Perpendicular Transects

Four perpendicular transects (cross sections) were surveyed; two at riffles and two at pools. Endpoints of each transect were marked with a pin, flagging, or stake and a GPS point was logged for location during subsequent monitoring events. Bank pins were placed on the left and right banks of the channel to document potential channel movement at each perpendicular transect.

3.3. 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, a qualitative severity rating score, and potential causes of bank erosion.

3.4. As-Built Surveys

An as-built topographic survey of the reconstructed stream channel was performed using control points provided by MDT (Appendix E).

3.5. Photo-Documentation

The project site was photographed from several locations to document vegetation establishment and stream bank conditions within the project site. All sites selected for photo-documentation were recorded on field maps with headings noted to allow for repetition during subsequent monitoring years. Photos were also taken at each perpendicular cross section in the upstream and downstream direction, as well as toward each stream bank. All photos of the project site are included in Appendix D.

4.0 RESULTS

4.1. Riparian Vegetation Inventory-Belt Transects

The two riparian belt transects included a 140 foot south (right) bank transect parallel to the downstream extent of the project reach and a 435 foot transect on the left (north) bank. Table 1 summarizes field data collection at each riparian transect including aerial percent cover of total vegetation, woody vegetation, and noxious weeds. Riparian vegetation transect results can be found in Appendix C.

Table 1. Riparian vegetation composition, Mill Creek.

Belt Transect	Length (ft)	Total % Riparian Cover	% Woody Cover	% Noxious Weed Cover
Right (south bank)	140	100	60	1
Left (north bank)	435	75	15	15
Total	575	80	25	8

Seven Montana State listed noxious weeds were identified on site in 2013. Observed weeds included broad-leaf pepperwort (*Lepidium latifolium*), a priority 2a weed; spotted knapweed (*Centaurea maculosa*), Canadian thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*), oxeye daisy (*Leucanthemum vulgare*), and common tansy (*Tanacetum vulgare*), priority 2b weeds; and cheat grass (*Bromus tectorum*), a priority 3 weed. All weeds were observed in trace (<1%) amounts.

4.2. Perpendicular Transects

Four perpendicular transects were surveyed, including two pools and two riffles, to document potential channel movement at each perpendicular transect. Plots for each surveyed transect are included in Appendix B. Transect #2 and #3 were surveyed at scour pools formed by woody debris jams. Woody debris jams may move during future flood events, creating new pool habitats in other locations. Average riffle depths were actually greater than the pool depths, indicating localized woody pool scour formations are relatively shallow. All transects will be re-surveyed during subsequent monitoring events to document substrate deposition, pool scour, and whether the channel is laterally moving at any of these locations.

4.3. Bank Erosion Inventory

Five eroding banks were observed within the project reach, and are illustrated on Figure 2 in Appendix A. Table 2 provides information for each eroding bank, including photo numbers, bank length, a qualitative bank erosion severity rating of each bank within the project site, and potential causes of erosion. A qualitative erosion severity rating was generated by observing substrate composition of the bank, vegetation composition, and whether depositional features such as point bars were developing near the erosional area. The bank identification number in Table 2 matches those displayed on Figure 2.

Two eroding banks, including EBL1 and EBL2, occur on the north streambank, just upstream of the reconstructed channel segment. These two banks were included in the

streambank erosion inventory due to the potential of these banks affecting the project reach.

Table 2. Mill Creek eroding bank inventory.

ID No.	Photo No.	Length (ft)	Severity	Description
EBL1 north bank	2938 to 2946	93	moderate	Plant community along stream bank consists of alder, poa pratensis, lupine, bromus inermis, and western wheatgrass. Bank erosion due to large point bar forming on the inside of the meander bend adjacent to the bank.
EBL2 north bank	2938 to 2946	114	moderate	Plant community along the streamback consists of reed canary grass, poa pratensis, ox-eye daisy, carex utriculata, goldenrod, scotch thistle, yarrow, knapweed, and smooth brome. Eroding bank due to point bar formation on the inside of the meander adjacent to the bank.
EBL3 north bank	2948	47	minor	Eroding bank begins at sunken root wads and extends downstream to large downed cottonwood. Left bank pool development and scouring around root wad is potential cause for bank erosion at this location. Erosion is occurring at the head of the former channel alignment. Vegetation consists of meadow foxtail, ox-eye daisy, knapweed, clover, kentucky bluegrass, and tansy.
EBL4 north bank	2955	45	minor	Bank sloughing, and root balls are falling in on both sides of the channel. Bank has several root balls from cut trees, potentially used in log revetment just downstream. No adjacent point bar formation. Instability potenially caused by removal of trees for use in log revetment construction, or from natural, minor channel adjustments following construction. Vegetation includes reed canary grass and smooth brome.
EBR1 south bank	2949	58	minor	Channel widening? Several trees fallen on right bank from undercutting--across from EBL4. Trees falling toward and away from the stream channel is evidence of undercutting and block failure. Does not appear much bank was lost to erosion. Bank vegetation is primarily cottonwood, alder, and smooth brome.

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Mill Creek Stream Mitigation site is intended to document whether the reconstructed segment of the channel is meeting performance standards outlined in the Army Corps 404 permit issued for the project. Table 3 summarizes the status of each performance criteria and monitoring requirement following the first year of monitoring.

Table 3. Summary of Mill Creek performance and reporting requirements.

Monitoring or Reporting Requirement	Parameter	Success Criteria	Status
1a	Riparian Cover	80% total vegetative coverage after 3rd year	Total vegetative cover of the project site is **80%** following first year of monitoring (100% of south bank and 75% of left bank).
1b	Riparian Cover	50% woody species coverage after 3rd year	Woody cover of the project site is **25%** following first year of monitoring (60% of south bank and 15% of north bank).
2	Streambank Stability	Identification of unstable stream banks within the project area	Five eroding bank segments were observed in 2013 and are considered minor or moderate severity. No banks were considered severerly eroding.
3	As-Built Drawings	As built drawings of the relocated channel at a 1:50 scale or smaller and planting schematic with a planted species list and number of plants planted	As-Built drawing and Planting Schematic provided in Appendix E
4	Perpendicular Transects	Establishment of 4 monitoring stations 75' apart with surveyed cross sections and bank pins installed as permanent reference points.	Transect results provided in Appendix B
5	Photo Points	Color photos at each monitoring station showing both banks and upstream and downstream views.	Photo Log provided in Appendix D

5.1. Riparian Cover

Vegetation along the south bank of Mill Creek was minimally disturbed during construction of the new channel alignment. Vegetation disturbance along the south bank was limited to a short (approximately 50') reach immediately adjacent to the new highway bridge. This channel segment has been stabilized with rock to protect the bridge infrastructure. As a result, the success of revegetation efforts should focus on the north bank along areas where construction equipment accessed the new channel alignment and filled the former channel configuration.

Total vegetative cover observed along the north bank riparian transect was 75%, which falls below the success criteria threshold of 80%. Patches of bare ground were observed beneath a stand of mature ponderosa pines and along the deactivated channel alignment. When factoring in the undisturbed south bank, total vegetative cover across the site was 80%, and meets the minimum success standard for this category.

Woody vegetation cover along the north bank was 15%, which falls well below the success criteria threshold of 50%. No woody vegetation was observed along the backfilled channel segment, and relatively few woody shrubs were observed along the north bank of the newly aligned channel. Several mature ponderosa pine trees remain along the north bank and provide the majority of the woody species composition. When factoring in the undisturbed south bank woody species cover, total woody cover for the site is 26%.

Weed species accounted for 15% of the vegetative cover along the north bank, 1% of the south bank, and 8% of the vegetation cover site-wide. Based on these results, weed control and the establishment of additional woody vegetation will be necessary along the north bank to meet performance criteria for riparian cover.

5.2. Bank Erosion Inventory

Three eroding streambanks were observed in the project area, while two additional eroding banks were identified immediately upstream of the project area (Table 2 and Figure 2, Appendix A). The eroding banks upstream of the project area were included in the bank inventory.

Bank erosion within the project site was limited to relatively short bank segments (45-58'). Eroding bank EBL3 (north streambank) occurs along the plug placed at the upstream end of the deactivated channel segment, and is due to localized scour produced by a downed tree. Erosion at this location is not severe, does not compromise downstream stability, and does not jeopardize any infrastructure.

Eroding bank EBL4 (north streambank) occurs along a bank with several tree stumps that appear to have either calved off of the adjacent stream bank, or were placed there in an attempt to protect the bank from erosion. The stumps are not secured to the bank

and will likely wash downstream during future flood events. The bank exhibits a native alluvial cobble and gravel toe, occurs along a relatively straight segment of the channel, and does not appear to jeopardize overall channel stability. As a result, of these observations, erosion at this location is considered minor.

Eroding bank EBR1 (south streambank) is similar to EBL4, in that it occurs along a relatively straight channel segment. Based on the location of this eroding bank being directly across the channel from EBL4, it appears the channel has slightly adjusted following construction. The bank exhibits a native cobble and gravel toe that appears to have mobilized during the last flood event, as evidenced by adjacent downed trees. Erosion at this location should be monitored to determine whether future protective measures are warranted to prevent lateral adjustments toward the highway.

Two eroding banks (EBL1 and EBL2) were observed upstream of the project reach. Relatively tall bank height, sparse woody riparian vegetation, and establishment of a large adjacent point bar contribute to erosion at these locations The channel makes a near 180-degree turn at this location, placing erosive stress along the entire meander bend. It is likely erosion will continue at this location until the channel has reached a stable planform configuration. Future movement of the channel may also result in alignment modifications within the project reach, depending on where bedload and woody debris deposits occur.

6.0 MANAGEMENT RECOMMENDATIONS

6.1. Woody Vegetation Establishment

Woody vegetation composition is relatively low along the north bank, which prevents achievement of the performance criteria for this category. Installation of additional woody vegetation is recommended within 25' of the bank, particularly within backfilled areas of the deactivated channel segment. No woody vegetation was observed within the backfilled channel segment. Installation of willows, alder, chokecherry, or Wood's rose within these areas would improve woody species composition within the riparian zone and assist in meeting this performance target.

6.2. Weed Control

Weed species comprised 15% of the north bank vegetation composition. Although the performance criteria for weed cover is currently being met site-wide, weed control efforts are warranted along the north bank to prevent the spread of these species. Weed species necessary to target include broad-leaf pepperwort (*Lepidium latifolium*), spotted knapweed (*Centaurea maculosa*), Canadian thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*), oxeye daisy (*Leucanthemum vulgare*), common tansy (*Tanacetum vulgare*), and cheat grass (*Bromus tectorum*). All weed species were observed in trace amounts across the mitigation site.

6.3. Channel Stability

The project reach exhibits a significant amount of recent bedload deposition, gravel point bar formation, and formation of woody debris jams. The result of these processes

includes some relatively minor lateral adjustments within the newly activated channel segment. Lateral bank adjustments are typical in streams exhibiting an abundance of bedload material, and should not be mistaken for overall channel instability. The stream banks within the project reach include a gravel/cobble toe overlain by a lens of finer gravel and vegetated topsoil. The banks are relatively steep and susceptible to lateral movements during high flows. Eliminating erosion from occurring within the entire project reach would require armoring each outside meander bend with oversized boulders, or constructing a series of barbs or vanes to deflect energy away from the banks. Neither of these approaches lends to development of a natural channel with supporting habitat components.

The approved 404 permit for the Mill Creek project states, “If any unstable stream banks are visible within the relocated channel, corrective measures will be required.” Three eroding banks occur within the relocated channel segment of the project reach (EBL3, EBL4, and EBR1), but should not be considered “unstable”. These banks exhibit minor bank sloughing, resulting in recruitment of gravel and woody debris to the channel, both of which are beneficial to maintaining trout habitat. These banks should be allowed to adjust laterally until such time as the channel configuration potentially threatens stability of the bridge or highway.

Two eroding banks occur on the same meander bend upstream of the relocated channel segment (EBL1 and EBL2). The landowner estimates the bank has retreated between 20 and 30 feet following construction of the project. This bank occurs on a very sharp bend of Mill Creek, where the channel turns approximately 135 degrees over a length of about 200 feet. This sharp turn in the channel will likely continue to result in lateral movement of the channel to the north until a stable meander radius is established. The landowner has attempted to slow the erosion by cabling a tree and placing large boulders along the bank; however, neither of these efforts is likely to successfully reduce the rate of lateral bank movement at this location. Erosion along these banks could be reduced with bioengineering techniques including installing a stone toe, resloping the vertical bank, and installing dense woody riparian vegetation.

6.4. Floodplain Fill

A chunk of asphalt was found in the materials used to fill the deactivated channel segment. It is unknown where the material used to fill the old channel originated, or whether that material came from excavating the new channel alignment. It is possible fragments of asphalt may have been mixed with native gravel and cobbles near the highway project where fill material was generated. It is recommended all fill materials used to fill deactivated channel segments be inspected for foreign materials prior to placement.

6.5. Livestock Access

Evidence of livestock access to the project reach was observed downstream of the Highway 93 Bridge. Although livestock scat and tracks were observed here, the project reach was not harmfully affected by grazing practices. If possible, livestock access should be limited to areas downstream of the bridge to allow time for revegetation

efforts upstream of the bridge to colonize. It does not appear livestock grazing currently occurs upstream of the bridge.

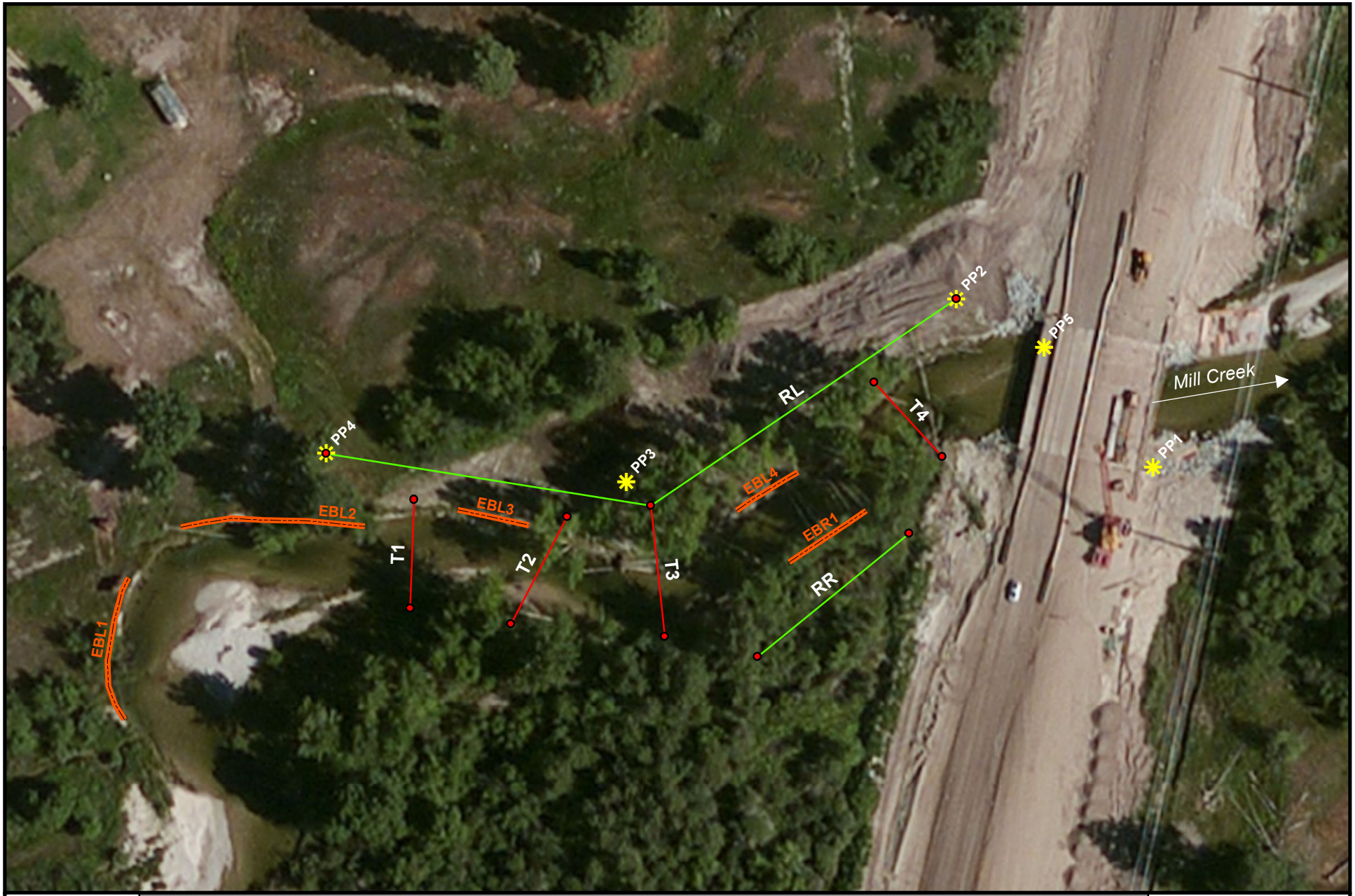
6.6. Woody Debris

Several woody debris jams have formed in the channel upstream of the bridge. These woody debris jams include trees that have been cut down, as well some that have naturally fallen into the creek. These debris jams are currently providing good aquatic habitat features, but should be monitored to ensure they do not create a large constriction upstream of the highway bridge. The bridge has been designed to convey a large flood event and will likely be successful at passing woody debris as well; however, periodic inspection of this bridge during and immediately following greater than bankfull flood events is recommended.

Appendix A

Project Map

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana



CONFLUENCE
consulting incorporated

Legend

- Photo Points
- Riparian and Perpendicular Transect Endpoints
- Eroding Banks
- Pool and Riffle Transects
- Riparian Transects

N

0 25 50 100 150 200 Feet

2013 Monitoring Mill Creek

Figure 2

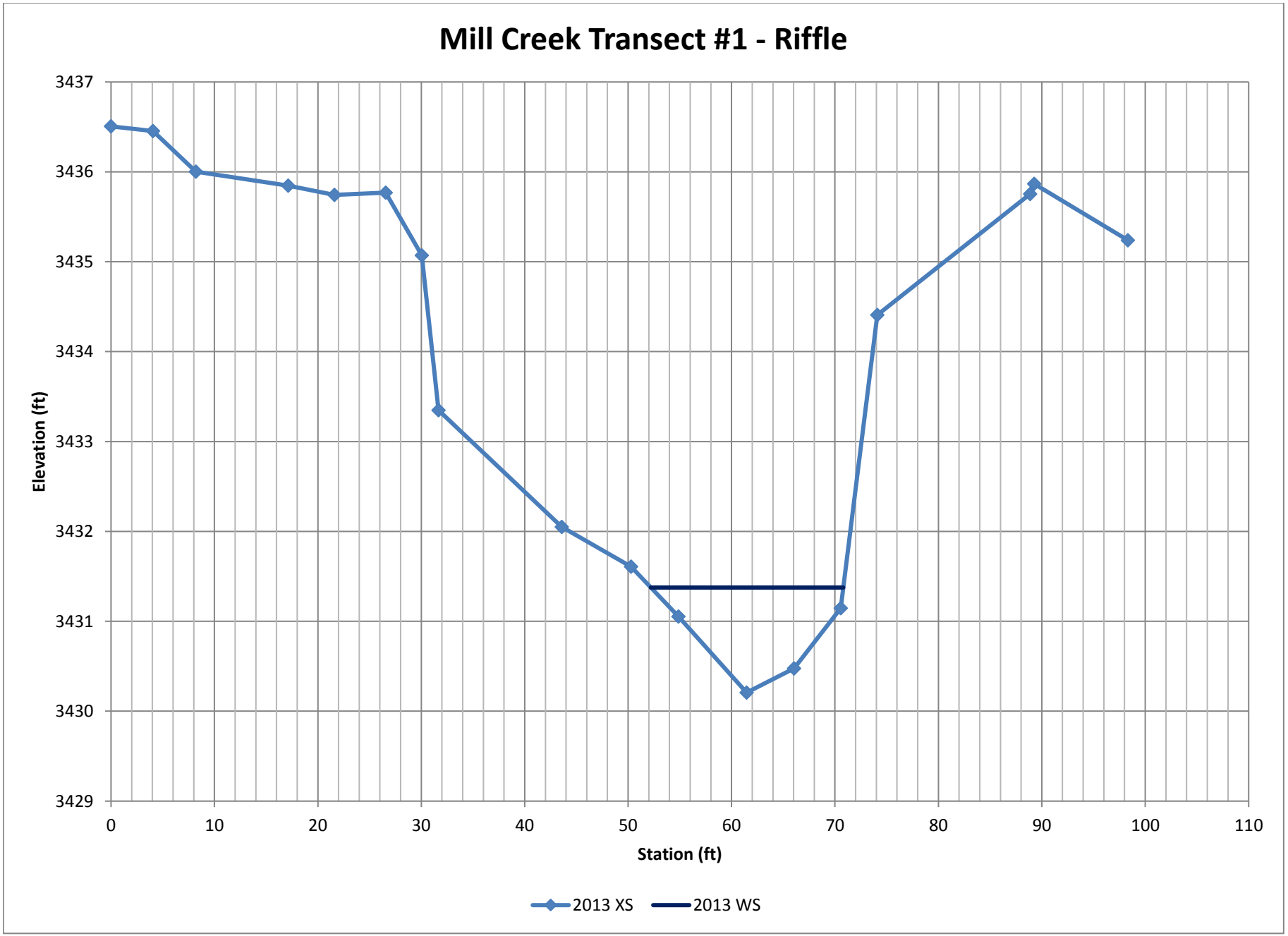
Date: 10/10/2013

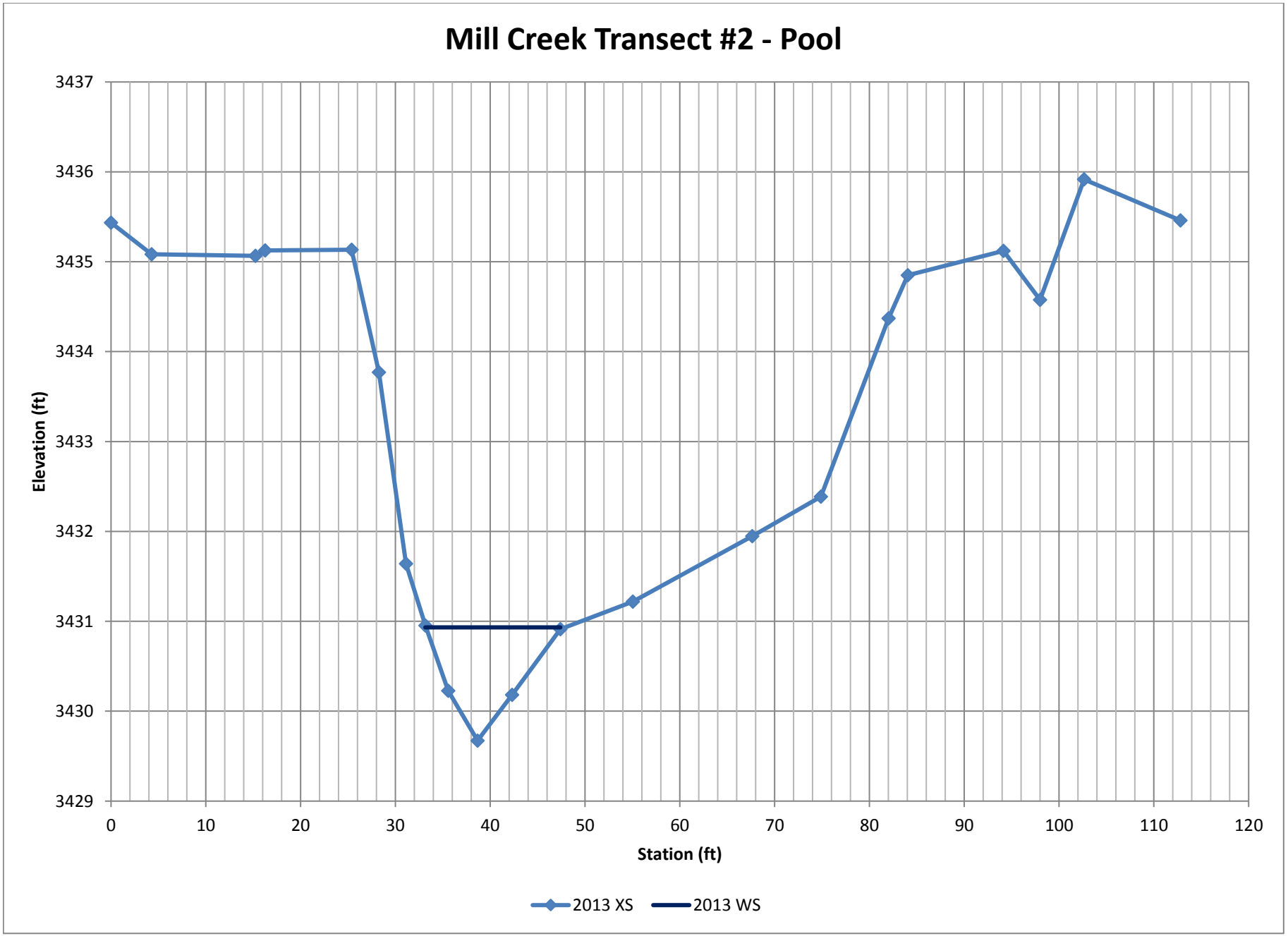
X:/MDT_.007/mains

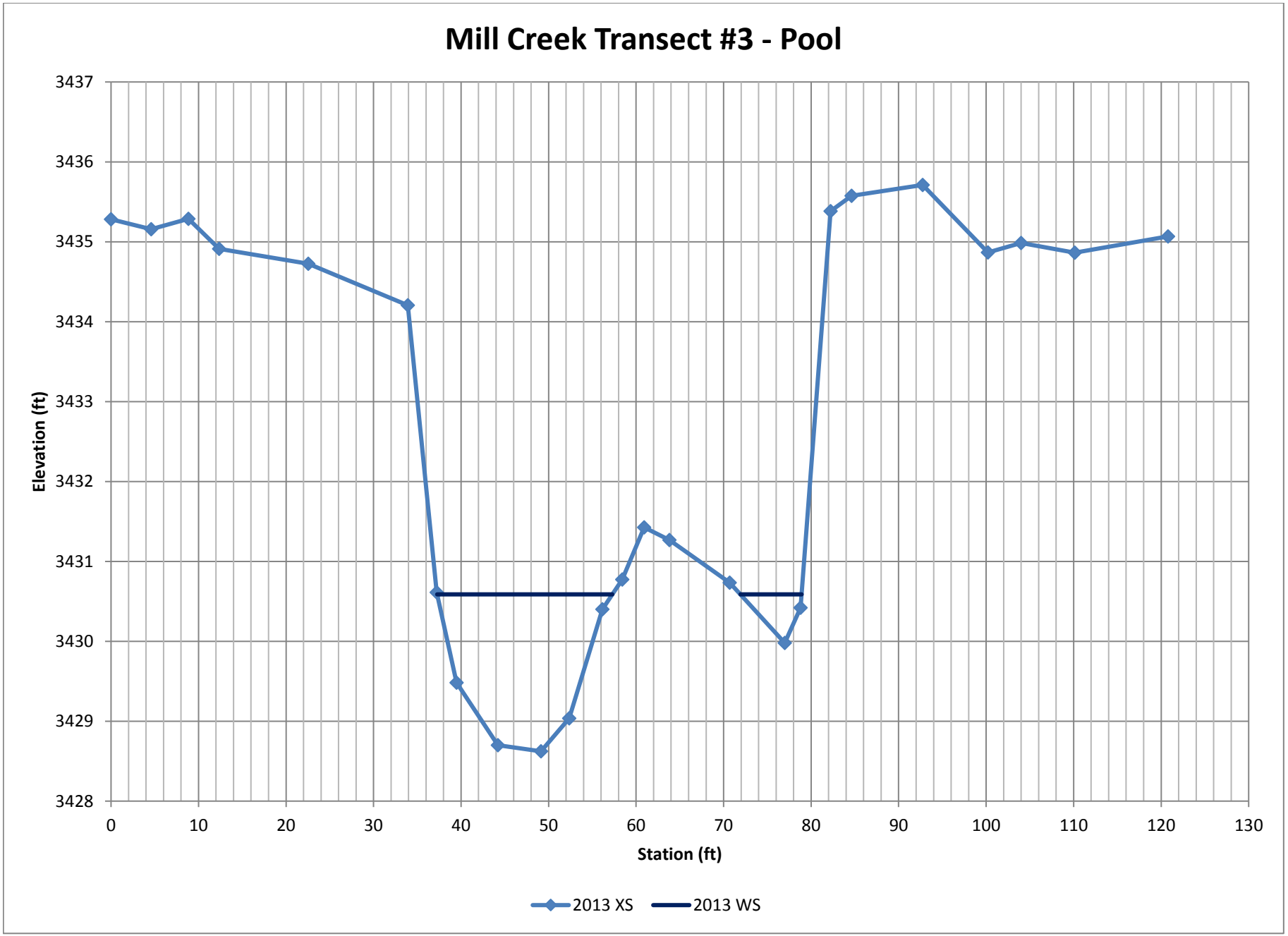
Appendix B

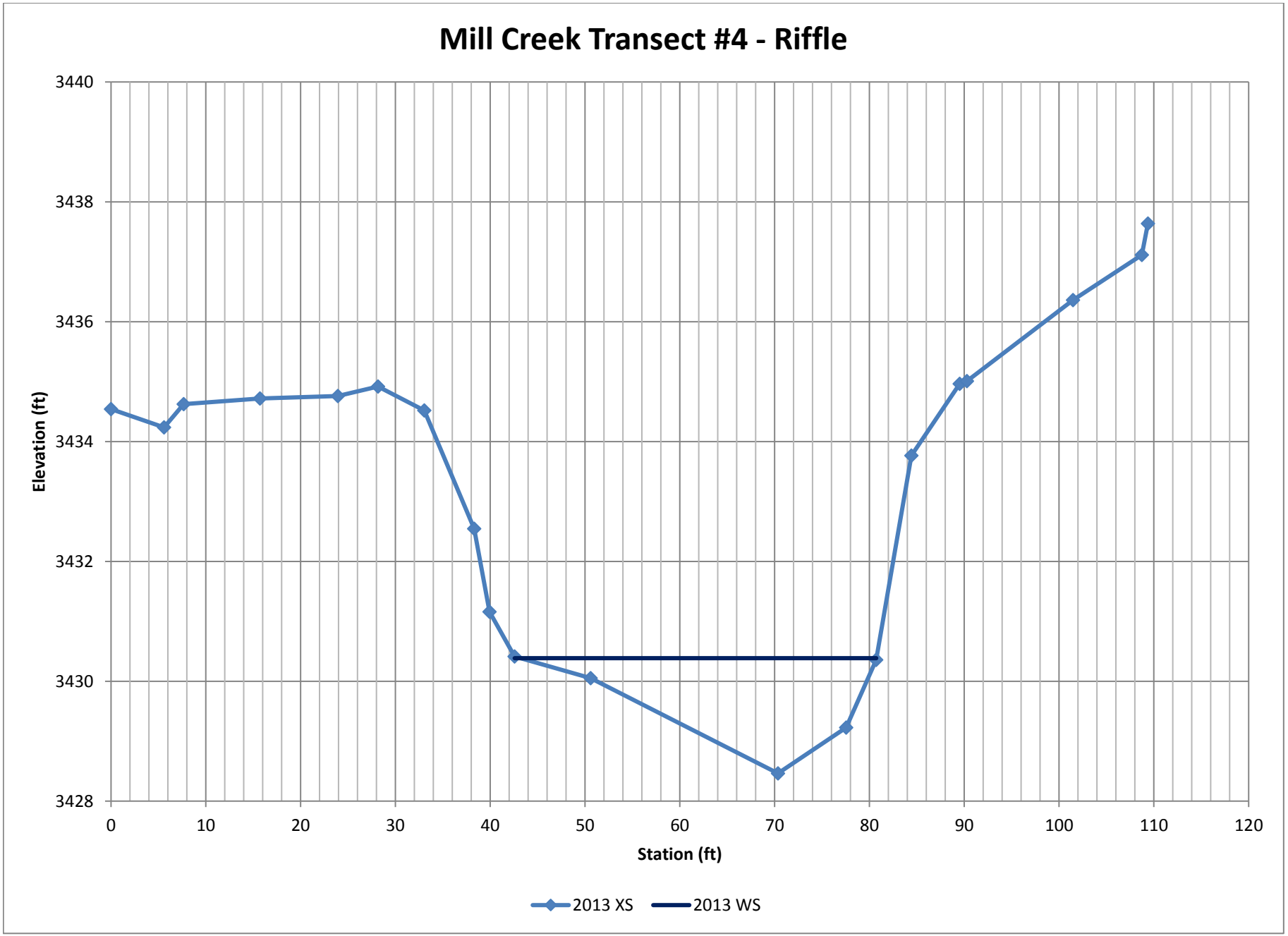
Perpendicular Transect Plots

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana


Mill Creek Transect #1 - Riffle
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
0
10
20
30
40
50
60
70
80
90
100
110
Station (ft)
2013 XS
2013 WS


Mill Creek Transect #2 - Pool
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
0
10
20
30
40
50
60
70
80
90
100
110
120
Station (ft)
2013 XS
2013 WS


Mill Creek Transect #3 - Pool
Elevation (ft)
3437
3436
3435
3434
3433
3432
3431
3430
3429
3428
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Station (ft)
2013 XS
2013 WS


Mill Creek Transect #4 - Riffle
Elevation (ft)
3440
3438
3436
3434
3432
3430
3428
0
10
20
30
40
50
60
70
80
90
100
110
120
Station (ft)
2013 XS
2013 WS

Appendix C

Riparian Vegetation Transect Results

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana

Interval Data Summary Report

Site: **Mill Creek**

date: 7/25/2013 8:18:27 AM

Transect Number: 1 **Compass Direction from Start:** _____

Interval Data:

Ending Station 435 **Community Type:** /

Species	Cover class	Species	Cover class
Achillea millefolium	1	Alnus incana	0
Bare Ground	4	Betula pumila	0
Bromus inermis	3	Bromus tectorum	1
Cirsium arvense	0	Equisetum arvense	0
Equisetum hyemale	0	Leucanthemum vulgare	2
Melilotus officinalis	3	Onopordum acanthium	1
Pascopyrum smithii	3	Phalaris arundinacea	2
Phleum pratense	1	Pinus ponderosa	2
Poa pratensis	3	Populus angustifolia	1
Rosa woodsii	1	Rumex crispus	0
Tanacetum vulgare	1	Tragopogon pratensis	0
Trifolium pratense	2	Verbascum thapsus	2

Transect Notes:

left bank. Start at third fence post at highway and head sw toward creek and marked cottonwood. Continue nw to large ponderosa pine furthest from bank is end point.

Interval Data Summary Report

Transect Number: 2 **Compass Direction from Start:** _____

Interval Data:

Ending Station 40 **Community Type:** /

Species	Cover class	Species	Cover class
Alnus incana	4	Betula pumila	5
Bromus inermis	3	Carex utriculata	1
Cirsium arvense	0	Crataegus douglasii	3
Leucanthemum vulgare	1	Pascopyrum smithii	2
Phalaris arundinacea	4	Poa pratensis	3
Populus angustifolia	5	Rosa woodsii	2
Scirpus microcarpus	0		

Ending Station 112 **Community Type:** /

Species	Cover class	Species	Cover class
Betula pumila	2	Carex utriculata	2
Juncus arcticus	2	Leucanthemum vulgare	0
Phalaris arundinacea	5	Poa pratensis	4

Ending Station 122 **Community Type:** /

Species	Cover class	Species	Cover class
Betula pumila	2	Bromus inermis	1
Carex utriculata	2	Crataegus douglasii	1
Juncus arcticus	3	Phalaris arundinacea	5
Poa palustris	3	Poa pratensis	3
Populus angustifolia	4	Ribes lacustre	1
Rosa woodsii	1	Salix bebbiana	3
Scirpus microcarpus	0		

Transect Notes:

Right (south) bank. Start at third fence post and dogleg slightly south to the largest cottonwood in the area (it is flagged).

Appendix D

Project Site Photos

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: July 25, 2013

CONFLUENCE

Photo Point 1.1
Description: View from south bridge abutment of north bank. **Compass**: 45 (Northeast)

Photo Point 1.2
Description: View from right bridge abutment down-stream. **Compass**: 45 (Northeast)

Photo Point 2.1 Start T1 (North Bank)
Description: View of bridge from Photo Point 2
Compass: 113 (East-Southeast)

Photo Point 2.2 Start T1 (North Bank)
Description: View from north bank of fence line looking across stream channel. **Compass**: 225 (Southwest)

Photo Point 2.3 Start T1 (North Bank)
Description: View from Photo Point 2 looking up-stream. **Compass**: 248 (West-Southwest)

Photo Point 2.4 Start T1 (North Bank)
Description: View of deactivated channel alignment.
Compass: 248 (West-Southwest)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: July 25, 2013

CONFLUENCE

Photo Point 2.5 Start T1 (North Bank)
Description: View of deactivated channel alignment.
Compass: 248 (West-Southwest)

Photo Point 3.1
Description: View of deactivated channel segment from Photo point 3. **Compass**: 68 (East-Northeast)

Photo Point 3.2
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 45 (East)

Photo Point 3.3
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 0 (North)

Photo Point 3.4
Description: View of deactivated channel plug from Photo Point 3. **Compass**: 315 (Northwest)

Photo Point 3.5
Description: View of the upstream extent of the deactivated channel segment. **Compass**: 270 (West)

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: July 25, 2013

CONFLUENCE

Photo Point 3.6
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 248

Photo Point 3.7
Description: View of north bank (foreground) and woody debris in the channel. **Compass**: 180 (South)

Photo Point 4.1 T1 Finish (North Bank)
Description: View looking across deactivated channel segment. **Compass**: 90 (East)

Photo Point 4.2 T1 Finish (North Bank)
Description: View across stream channel toward south bank. **Compass**: 180 (South)

Photo Point 4.3 T1 Finish (North Bank)
Description: View of point bar formation from Photo Point 4. **Compass**: 225 (Southwest)

Photo Point 4.4 T1 Finish (North Bank)
Description: View of boulders, root wads and logs placed along the north bank. **Compass**: 248

PHOTO INFORMATION

PROJECT NAME: Mill Creek Stream Mitigation Site

DATE: July 25, 2013

CONFLUENCE

Photo Point 5.1
Description: View looking upstream of south bank taken from bridge. **Compass**: 248 (West-Southwest)

Photo Point 5.2
Description: View looking upstream from bridge.
Compass: 203 (South-Southwest)

Photo Point 5.3
Description: View of north bank from bridge.
Compass: 270 (West)

PHOTOGRAPHIC INFORMATION page 1 of 18

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 4 South Downstream

Transect 4 South Looking Upstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 3 South Looking North

Transect 3 South Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 3 South Looking Upstream

Transect 2 South Looking North

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 2 South Looking Upstream

Transect 2 South Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 1 South Looking Northwest

Transect 1 South Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 1 South Looking Upstream

Transect 1 North Looking Southeast

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 1 North Looking Upstream

Transect 1 North Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 2 North Looking Southeast

Transect 2 North Looking Upstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 2 North Looking Downstream

Transect 3 North Looking Southeast

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 3 North Looking Upstream

Transect 3 North Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 4 North Looking Southeast

Transect 4 North Looking Downstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 4 North Looking Upstream

West Bridge Looking Upstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

West Bridge Looking North

West Bridge Looking South

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

West Bridge Looking Upstream

West of Bridge Looking Downstream—East

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

West of Bridge Looking Downstream—Southeast

Transect 3 in Creek—Looking Upstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 3 in Creek Looking Downstream

Transect 1 In Creek Looking Upstream

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

Transect 1 in Creek Looking Downstream

East Bridge Looking North

PROJECT NAME: MDT Stream Mitigation Mill Creek

DATE: August 28, 2013

East Bridge Looking Downstream

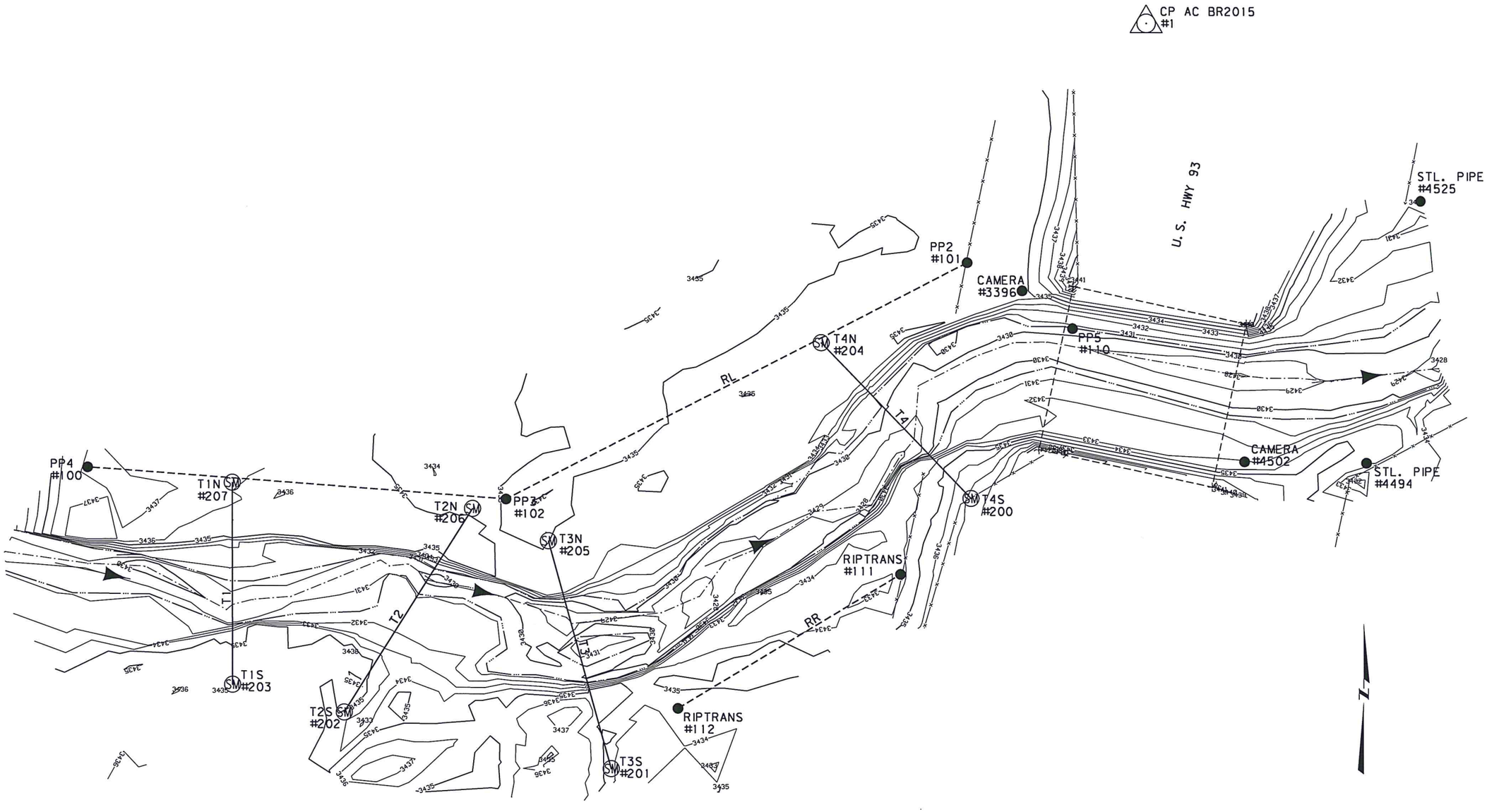
East Bridge Looking Downstream

Appendix E

As-Built Surveys & Planting Schematics

MDT Stream Mitigation Monitoring
Mill Creek
Ravalli County, Montana

CONTROL TABLE				
PNT#	NORTHING	EASTING	ELEV.	DESCRIPTION
1	800550.322	796062.299	3440.783	CP AC BR2015
2	799324.627	795743.954	3443.762	CP AC BS2015

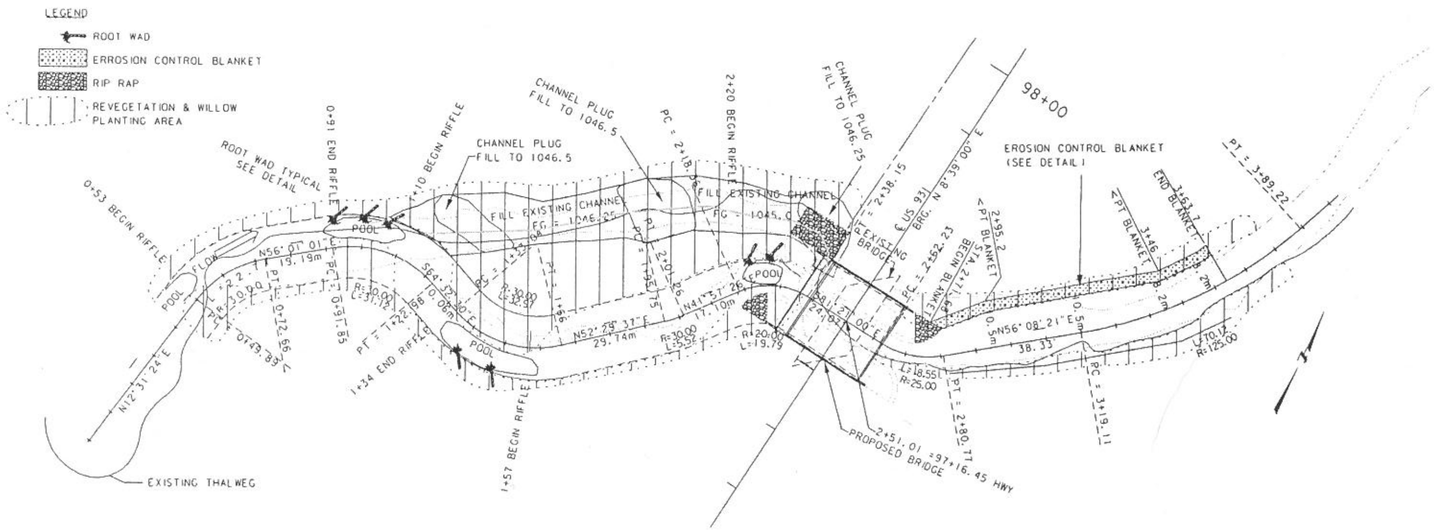


SURVEYOR NOTES:

1. THIS SURVEY IS BASED ON FOUND MDT ALUMINUM CAPS STAMPED BR2015 AND BS2015 BUT THEY DO NOT HAVE ESTABLISHED MDT COORDS AND ELEVATIONS. THEREFORE LOCAL CONTROL WAS ESTABLISHED FOR THIS SITE WITH TRIMBLE GPS RTK SURVEY AND THE APPROXIMATE ASSUMED ELEVATION AT MDT ALUM CAP BR2015.
2. THE COORDINATES SHOWN HEREON ARE BASED ON MONTANA STATE PLANE GRID

0 25 50 75 100

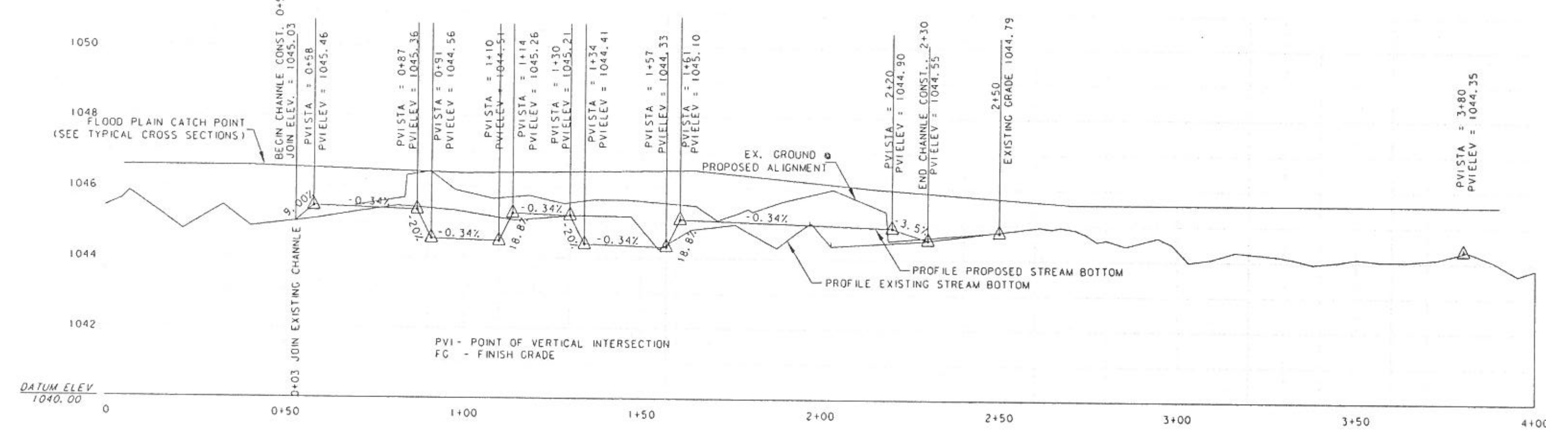
3	MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\MILL CREEK\MillcreekPLAN .dgn	DESIGNED BY	ARNE W		MILL CREEK TOPO	MDT STREAM MITIGATION MONITORING SURVEY
2		12/9/2013	REVIEWED BY				
1		11:04:43 AM awiebe	CHECKED BY	LARRY R			



COORDINATE TABLE

STATION		NORTHING	EASTING
0+00.00	POT	30 048.8339	55 813.2378
0+49.89	PC	30 097.5369	55 824.0557
0+61.86	PI	30 109.2191	55 826.6506
0+72.66	PT	30 115.9079	55 836.5735
0+91.85	PC	30 126.6342	55 852.4861
1+08.98	PI	30 136.2068	55 866.6871
1+22.98	PT	30 128.8451	55 882.1502
1+33.04	PC	30 124.5211	55 891.2326
1+51.41	PI	30 116.6240	55 907.8201
1+66.00	PT	30 127.8094	55 922.3938
1+95.75	PC	30 145.9183	55 945.9883
1+98.51	PI	30 147.6025	55 948.1827
2+01.26	PT	30 149.6596	55 950.0321
2+18.36	PC	30 162.3748	55 961.4637
2+29.15	PI	30 170.3985	55 968.6774
2+38.15	PT	30 168.7758	55 979.3445
2+62.23	PC	30 165.1551	56 003.1444
2+71.95	PI	30 163.6925	56 012.7585
2+80.77	PT	30 169.1110	56 020.8338
3+19.11	PC	30 190.4690	56 052.6647
3+55.11	PI	30 210.5314	56 082.5648
3+89.22	PT	30 243.4254	56 097.2103
4+03.47	POT	30 256.4436	56 103.0064

PLAN



PROFILE

MILL CREEK
CHANNEL
RESTORATION
DETAIL
STA. 97+16
SHEET 1 OF 3
NO SCALE

LAND & WATER CONSULTING, INC.

MONTANA CADD

MDT MONTANA DEPARTMENT OF TRANSPORTATION

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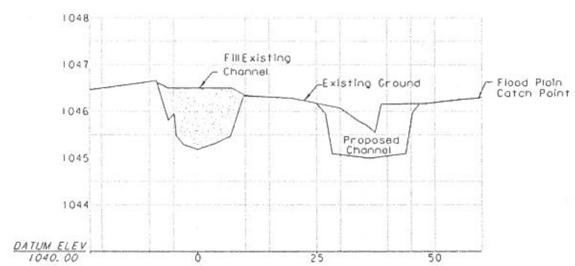
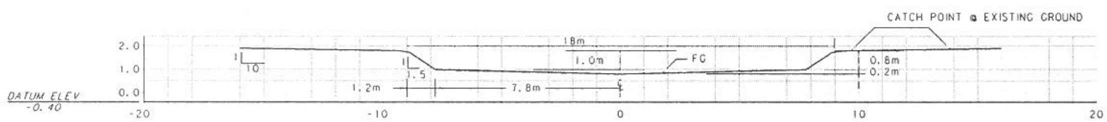
STATE	PROJECT NUMBER	SHEET NO.
MONTANA	NH 7-1(94)54	25

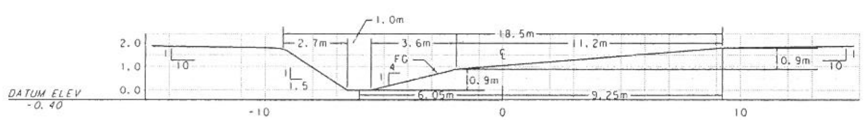
BEAR CREEK ROAD - SOUTH



CROSS SECTIONS 1+97



TYPICAL RIFFLE CROSS SECTION

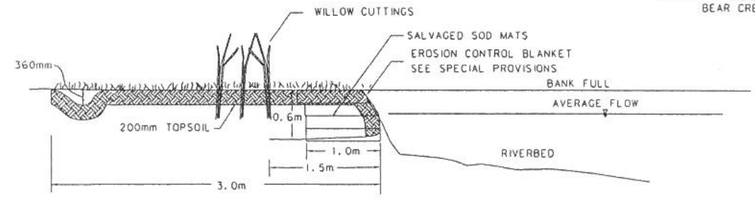


TYPICAL POOL LEFT CROSS SECTION

STATION From	STATION To	POOL LEFT	RIFFLE (INCLUDES 4m TRANSITION)	POOL RIGHT
0+00	0+53			
0+53	0+91		X	
0+91	1+10	X		
1+10	1+34		X	
1+34	1+57			X
1+57	2+20		X	
2+20	2+30	X		
2+30	5+00			

NOTES:

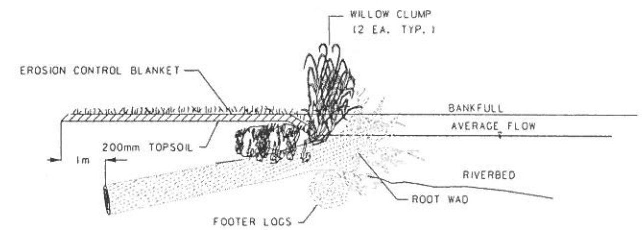
1. SEE PLANS FOR POOL LOCATION. POOL LEFT (PL) SHOWN; MIRROR ABOUT CENTERLINE (℄) FOR POOL RIGHT LOOKING DOWNSTREAM.
2. TRANSITION 4.0m BETWEEN POOL : RIFFLE.
3. ROUND SLOPES FOR NATURAL APPEARANCE.



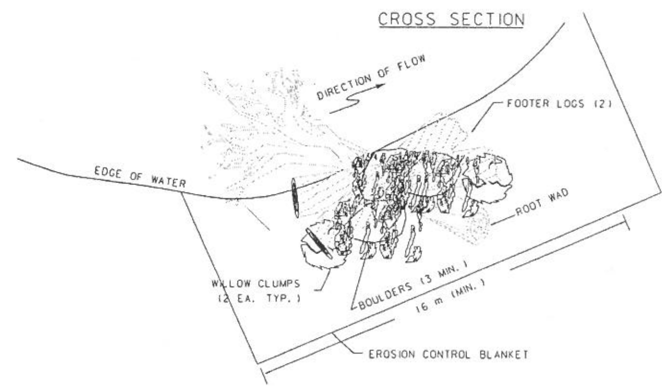
1. SUB EXCAVATE BANKS 0.6 METERS.
2. LAY LOWER BLANKET MINIMUM 1.5 METERS FROM EDGE OF BANK.
3. BACK FILL WITH NATIVE MATERIAL AND 0.2 METERS TOPSOIL.
4. FACE STREAM BANK BACKFILL WITH 1.0 METERS OF SALVAGED SOD MATS.
5. WRAP BLANKET AND EXTEND 3.0 METERS MIN. FROM BANK EDGE.

EROSION CONTROL BLANKET TYPICAL

MILL CREEK



CROSS SECTION



PLAN

ROOT WAD TYPICAL

MILL CREEK

MILL CREEK
CHANNEL
RESTORATION
DETAIL
STA. 97+16
SHEET 2 OF 3
NO SCALE

LAND & WATER CONSULTING, INC.

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