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# MONTANA DEPARTMENT OF TRANSPORTATION STREAM MITIGATION MONITORING REPORT

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*North Fork Bear Creek  
Ravalli County, Montana*

*Year Project Completed: 2011  
Monitoring Report #2: Submitted December, 2014*



Prepared for:

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# **MONTANA DEPARTMENT OF TRANSPORTATION**

## **STREAM MITIGATION MONITORING REPORT #2:**

**YEAR 2014**

*North Fork Bear Creek  
Ravalli County, Montana*

MDT Project Number: NH-7-1(114)56  
Control Number: 2015 003

MTFWP: MDT-R2-64-2010  
USACE: NWO-1997-90821-MTH

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December 2014

CCI Project No: MDT\_.007



## TABLE OF CONTENTS

1.0	Introduction .....	1
2.0	Site Location .....	2
3.0	Monitoring Methods.....	2
3.1.	Riparian Vegetation Establishment.....	2
3.2.	Stream bank Stability .....	2
3.3.	Photo Documentation .....	2
3.4.	As Built Drawings.....	4
4.0	Results .....	4
4.1.	Riparian Vegetation Inventory.....	4
4.2.	Bank Erosion Inventory.....	7
5.0	Comparison of Results to Performance Criteria .....	8
5.1.	Riparian Cover .....	8
5.2.	Streambank Stability .....	9
6.0	Management Recommendations .....	9
6.1.	Recommendations for installing woody cuttings .....	9
6.2.	Coir Fabric Installation .....	10
6.3.	Weed Control.....	10
7.0	Literature Cited .....	11

## TABLES AND FIGURES

Table 1.	Visual estimate of plant coverage at North Fork Bear Creek Stream Mitigation Site in 2013 and 2014.....	4
Table 2.	Comprehensive list of plant species observed at the North Fork Bear Creek Stream Mitigation Site in 2013 and 2014.....	5
Table 3.	Weeds observed within the North Fork Bear Creek riparian zone in 2014.....	7
Table 4.	Performance results of North Fork Bear Creek three years following project completion.....	8

Figure 1. Project location of North Fork Bear Creek stream mitigation site.....3  
Figure 2. Project Site Map .....Appendix A

**APPENDICES**

- Appendix A: Project Site Map
- Appendix B: Project Area Photos
- Appendix C: As Built Drawings and Design Schematics

Cover. View of North Fork Bear Creek upstream of U.S. Hwy 93 taken in 2014.

## 1.0 INTRODUCTION

The following report presents the results of the second year of post stream reconstruction monitoring at the U.S. Highway 93 crossing at North Fork Bear Creek near Victor, Montana. This 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 performance standards. The project was constructed in 2011; therefore, these results provide documentation of the site's condition three years following the project's completion.

The Montana Department of Transportation (MDT) requested authorization to replace bridges at North and South Fork Bear Creek, construct a new stream channel segment, and to place 0.07 acres of wetland fill. The North Fork Bear Creek work included: removal and replacement of the existing bridge, placement of rock at bridge abutments, placement of fill within the stream channel, creation of a new stream channel, and removal of gabions downstream of the bridge. Stream mitigation was required to offset placement of riprap and other fill materials within the ordinary high watermark of the stream corridor.

Mitigation performance standards adopted for the reconstructed segment of the North Fork Bear Creek site include:

### 1. Riparian vegetation coverage

- a) Greater than 50% areal coverage of desirable perennial plants within the riparian buffer zone. Desirable plants include seeded species and those colonizing from adjacent undisturbed habitats.
- b) Greater than 25% areal coverage of woody riparian shrubs and/or trees within the riparian buffer zone.
- c) Less than 10% areal coverage of Montana State listed noxious weeds within the riparian buffer zone.

### 2. Streambank Stability

- a) Less than 25% of total bank length exhibiting signs of active erosion/cutting.

Additional reporting requirements included in the monitoring plan include:

1. **As-built** - An as-built drawing will be prepared with a list of plantings for the riparian areas within the stream channel construction zone.
2. **Weed Control** - Monitoring will include identification of state designated noxious weeds and an estimate of areal coverage of each weed species.
3. **Photo Points** - A minimum of 4 photo points will be established to document conditions along the newly constructed sections.

- a) Photo points will be established to show upstream and downstream bank conditions at bridge locations.
- b) Streambank reconstruction not associated with bridges will include photo points from upstream and downstream angles.

Results of the second year of monitoring in 2014 are presented in Section 4, and are compared to the adopted performance standards in Section 5. Section 6 provides management and recommendations for future projects to maximize the potential for meeting all performance criteria. A site map of the project area is included in Appendix A, and photo-documentation of the site during the 2013 and 2014 monitoring events is included in Appendix B. The as-built topographic survey of the project site as surveyed in 2013 is included in Appendix C as well as the design schematics for the project area.

## **2.0 SITE LOCATION**

The monitoring reach includes approximately 300 feet of the North Fork of Bear Creek, and extends 110 feet upstream and 100 feet downstream of the U.S. 93 Bridge. The project site is located in Section 31, Township 8 North, Range 20 West, and is approximately 1 mile south of Victor, Montana (Figure 1).

## **3.0 MONITORING METHODS**

Monitoring field crews visited the project site on July 23, 2014. The following data were collected at the North Fork Bear Creek stream mitigation site:

### **3.1. Riparian Vegetation Establishment**

Visual estimates of all vegetation species, woody species, and noxious weeds were performed within riparian buffer areas extending 25 feet on either side of the active stream channel. Percent cover was recorded for each vegetative category based on ocular estimates.

### **3.2. Stream bank Stability**

Both streambanks within the project area were visually assessed to document eroding streambanks. Eroding streambanks were labeled with a specific numeric identifier, photographed, and a GPS location was recorded.

### **3.3. Photo Documentation**

Four photo points were selected to photo-document vegetation establishment and streambank conditions within the project site. Photo documentation includes upstream and downstream bank conditions at the Highway 93 Bridge. All sites selected for photo-documentation were recorded using GPS and compass direction noted to allow for repetition during future monitoring (Appendix B).

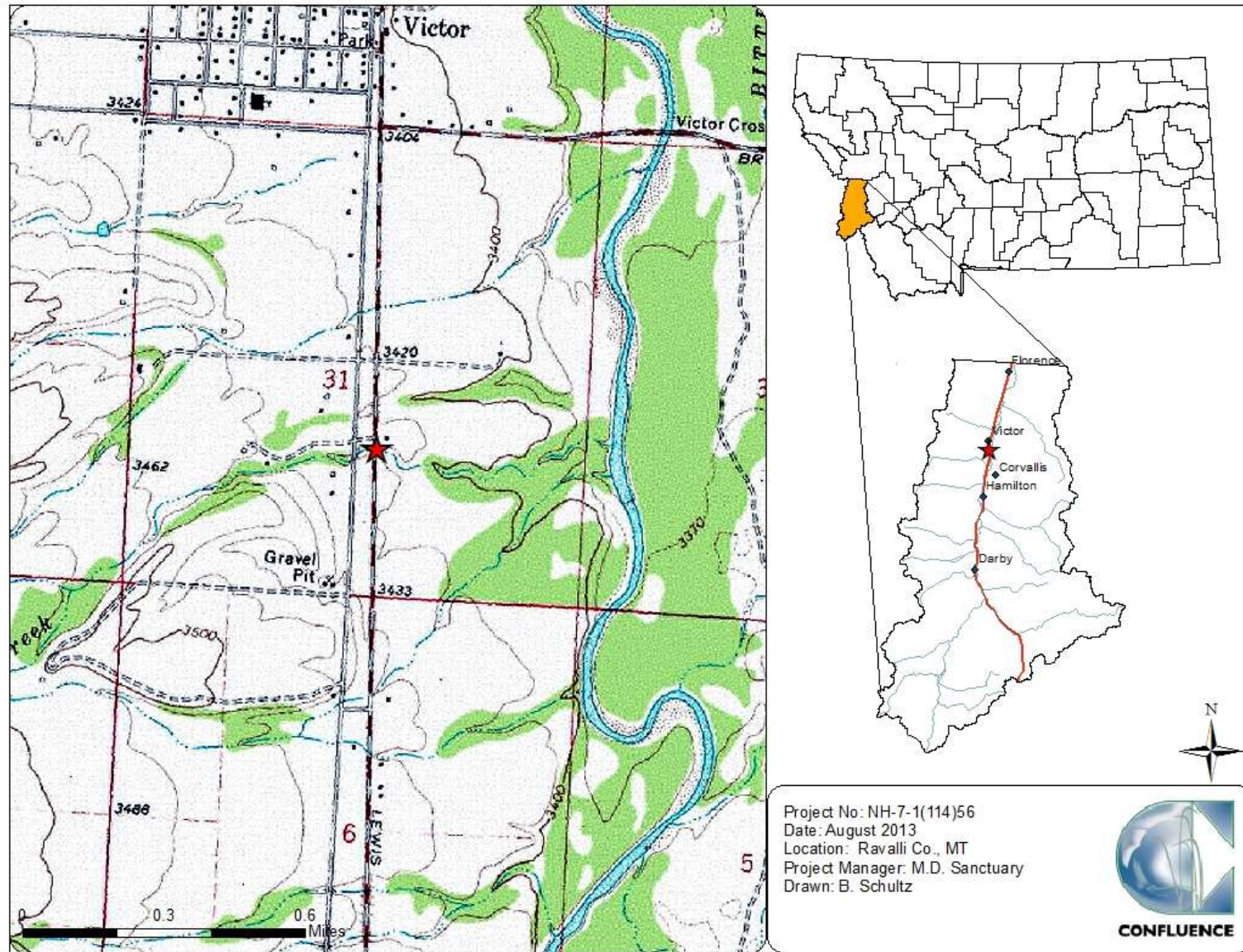


Figure 1. Project location of North Fork Bear Creek stream mitigation site.



### 3.4. As Built Drawings

An as-built topographic drawing of the project site was prepared as part of the 2013 (Year 1) monitoring, and included one-foot elevation contours and control points established by MDT during project construction (Appendix C).

## 4.0 RESULTS

### 4.1. Riparian Vegetation Inventory

Results of the 2013 and 2014 visual estimates of areal coverage are summarized in Table 1, and are separated into total vegetative cover, cover by woody species, and cover of noxious weeds. In 2014, approximately 10% of the project site was bare ground, with 60% of the area vegetated with herbaceous species and 30% woody species. The site exhibited a relatively high percentage of noxious weeds, estimated at approximately 35% of the total cover. Overall results as compared to 2013 were very similar, with a slight increase in percent woody cover from 27% to 30%. This result is likely due to maturation of woody species observed following an additional growing season.

**Table 1. Visual estimate of plant coverage at North Fork Bear Creek Stream Mitigation Site in 2013 and 2014.**

YEAR	Total % Riparian Cover	% Bare Ground	% Woody Cover	% Noxious Weed Cover
2013	90	10	27	35
2014	90	10	30	35

Table 2 includes a comprehensive list of plant species observed along the new channel alignment and riparian buffer areas in 2013 and 2014. Sixty-nine species were observed in 2014, representing an increase by 24 species from 2013. In 2014, 44% of species observed were hydrophytic based on the 2014 National Wetland Plant List (Lichvar et al 2014).

The relatively steep stream bank along the left (north) bank of the channel upstream of the Highway 93 Bridge may hinder the growth of riparian vegetation in this area. Downstream of the bridge, stream banks are less steep and cottonwoods (*Populus sp.*) and grasses (*Poa*, *Elymus*, *Phleum*, and *Phalaris spp*) are abundant.

**Table 2. Comprehensive list of plant species observed at the North Fork Bear Creek Stream Mitigation Site in 2013 and 2014.**

Scientific Name	Common Name	WMVC Indicator Status*
<i>Achillea millefolium</i>	Common Yarrow	FACU
<i>Agropyron cristatum</i>	Crested Wheatgrass	NL
<i>Agrostis gigantea</i>	Black Bent	FAC
<i>Alnus incana</i>	Speckled Alder	FACW
<i>Alyssum alyssoides</i>	Pale Alyssum	NL
<i>Antennaria parvifolia</i>	Nuttall's Pussytoes	NL
<i>Aster sp.</i>	Aster	NL
<i>Bromus inermis</i>	Smooth Brome	FAC
<i>Bromus tectorum</i>	Cheatgrass	NL
<i>Centaurea stoebe</i>	Spotted Knapweed	NL
<i>Cirsium arvense</i>	Canadian Thistle	FAC
<i>Convolvulus arvensis</i>	Field Bindweed	NL
<i>Cornus alba</i>	Red Osier	FACW
<i>Crataegus douglasii</i>	Black Hawthorn	FAC
<i>Cynoglossum officinale</i>	Gypsy-Flower	FACU
<i>Dactylis glomerata</i>	Orchard Grass	FACU
<i>Dasiphora fruticosa</i>	Golden-Hardhack	FAC
<i>Deschampsia cespitosa</i>	Tufted Hairgrass	FACW
<i>Elymus repens</i>	Creeping Wild Rye	FAC
<i>Elymus trachycaulus</i>	Slender Wild Rye	FAC
<i>Epilobium ciliatum</i>	Fringed Willowherb	FACW
<i>Festuca idahoensis</i>	Bluebunch Fescue	FACU
<i>Geranium viscosissimum</i>	Sticky Purple Crane's-Bill	FACU
<i>Geum macrophyllum</i>	Large-Leaf Avens	FAC
<i>Glyceria striata</i>	Fowl Manna Grass	OBL
<i>Hordeum jubatum</i>	Fox-Tail Barley	FAC
<i>Juncus sp.</i>	Rush	NL
<i>Lactuca serriola</i>	Prickly Lettuce	FACU
<i>Leucanthemum vulgare</i>	Ox-Eye Daisy	FACU
<i>Medicago lupulina</i>	Black Medick	FACU
<i>Melilotus officinalis</i>	Yellow Sweet-Clover	FACU
<i>Mentha arvensis</i>	American Wild Mint	FACW
<i>Osmorhiza occidentalis</i>	Sweet-cicely	NL
<i>Pascopyrum smithii</i>	Western-Wheat Grass	FACU
<i>Phalaris arundinacea</i>	Reed Canary Grass	FACW
<i>Phleum pratense</i>	Common Timothy	FAC
<i>Picea pungens</i>	Blue Spruce	FAC

\*Based on Lichvar et al 2014.  
New species identified in 2014 are **bolded**.

**Table 2 (Continued). Comprehensive list of plant species observed at the North Fork Bear Creek Stream Mitigation Site in 2013 and 2014.**

Scientific Name	Common Name	WMVC Indicator Status*
<i>Pinus ponderosa</i>	Ponderosa Pine	FACU
<b><i>Poa palustris</i></b>	<b>Fowl Blue Grass</b>	<b>FAC</b>
<i>Poa pratensis</i>	Kentucky Blue Grass	FAC
<i>Polygonum sp.</i>	Knotweed Complex	NL
<i>Populus angustifolia</i>	Narrow-Leaf Cottonwood	FACW
<i>Populus balsamifera</i>	Balsam Poplar	FAC
<b><i>Potentilla anserina</i></b>	<b>Silverweed</b>	<b>OBL</b>
<b><i>Prunella vulgaris</i></b>	<b>Common Selfheal</b>	<b>FACU</b>
<i>Prunus virginiana</i>	Choke Cherry	FACU
<i>Pseudotsuga menziesii</i>	Douglas-Fir	FACU
<i>Ranunculus sp.</i>	Buttercup	NL
<b><i>Ribes lacustre</i></b>	<b>Bristly Black Gooseberry</b>	<b>FAC</b>
<i>Rosa woodsii</i>	Woods' Rose	FACU
<b><i>Rubus sp.</i></b>	<b>Raspberry sp.</b>	<b>NL</b>
<b><i>Rumex acetosa</i></b>	<b>Garden Sorrel</b>	<b>FAC</b>
<i>Rumex acetosella</i>	Common Sheep Sorrel	FACU
<i>Salix amygdaloides</i>	Peach-Leaf Willow	FACW
<b><i>Salix bebbiana</i></b>	<b>Gray Willow</b>	<b>FACW</b>
<i>Salix drummondiana</i>	Drummond's Willow	FACW
<i>Salix lasiandra</i>	Pacific Willow	FACW
<i>Salix sp.</i>	Willow	NL
<b><i>Sinapis arvensis</i></b>	<b>Corn Mustard</b>	<b>NL</b>
<b><i>Solanum dulcamara</i></b>	<b>Climbing Nightshade</b>	<b>FAC</b>
<i>Solidago canadensis</i>	Canadian Goldenrod	FACU
<i>Sonchus arvensis</i>	Field Sow-Thistle	FACU
<i>Symphoricarpos albus</i>	Common Snowberry	FACU
<i>Tanacetum vulgare</i>	Common Tansy	FACU
<i>Taraxacum officinale</i>	Common Dandelion	FACU
<i>Tragopogon dubius</i>	Meadow Goat's-beard	NL
<i>Trifolium pratense</i>	Red Clover	FACU
<i>Trifolium repens</i>	White Clover	FAC
<i>Verbascum thapsus</i>	Great Mullein	FACU

\*Based on Lichvar et al 2014.  
New species identified in 2014 are **bolded**.

The vegetation inventory along the North Fork Bear Creek identified seven Montana State Listed noxious weed species, and one Montana State Regulated plant occurring within the riparian corridor (Table 3). Locations of all weed observations are provided on Figure 2 in Appendix A. Visual observations estimated approximately 35% of the project area has been colonized by weeds. Weeds were observed on both stream banks, and were primarily concentrated upstream of the Highway 93 Bridge. It should be noted that a horse corral exists immediately adjacent to the reconstructed channel segment on the north bank upstream of the Highway 93 Bridge. This corral is entirely bare ground, and may contribute to weed propagation in the mitigation site.

**Table 3. Weeds observed within the North Fork Bear Creek riparian zone in 2014.**

Category*	Scientific Name	Common Name
Priority 1B	<i>Polygonum sp.</i>	Knotweed Complex
Priority 2B	<i>Centaurea stoebe</i>	Spotted Knapweed
	<i>Cirsium arvense</i>	Canadian Thistle
	<i>Convolvulus arvensis</i>	Field Bindweed
	<i>Cynoglossum officinale</i>	Gypsy-Flower
	<i>Leucanthemum vulgare</i>	Ox-Eye Daisy
	<i>Tanacetum vulgare</i>	Common Tansy
Priority 3 State Regulated	<i>Bromus tectorum</i>	Cheatgrass

\*Based on the MSU Extension Service's Montana Noxious Weed list, 2013

Attempts at establishing woody riparian vegetation within the project reach included installing cuttings along the banks upstream and downstream of the Highway 93 Bridge. Cottonwood and willow cuttings installed along the banks were unsuccessful. No cuttings were found alive during 2013 or 2014 field observations. Upon inspection, all cuttings were installed to a depth of approximately one foot, with 4 to 5 feet of the stem extending above ground. High mortality rates were attributed to the inability of the cuttings to extend roots to the low water table elevation.

#### **4.2. Bank Erosion Inventory**

Field examination of the North Fork Bear Creek project site documented no eroding streambanks within the project area. New banks with large woody debris installations appeared mostly stable with no undercutting or lateral channel migration evident.

The trunk of one root wad installed upstream of Highway 93 appeared more exposed from the year prior (see Photo 2 in Appendix B). The exposure of this trunk appears as a result of the loss of cobble material placed on the upper six inches of the bank during high flows in 2014. Cobble materials placed over this root wad were covered with a layer of topsoil and coir fabric during construction; however, the fabric has peeled back from the top of the bank and is no longer providing protection of the upper bank. If additional cobbles adjacent to this root wad mobilize during subsequent high flows, the root ball may create a scouring hydraulic against the bank, reducing the ability of the

root wad to provide bank protection. Although the bank is not currently considered eroding due to the lack of lateral channel movement, continued monitoring is highly recommended to determine whether this segment of the project reach becomes more susceptible to erosion.

## 5.0 COMPARISON OF RESULTS TO PERFORMANCE CRITERIA

Monitoring of the North Fork Bear Creek Stream Mitigation site is intended to document whether the reconstructed segment of the channel is meeting performance standards outlined in the North Fork Bear Creek Mitigation Plan. The second year of monitoring indicates three of the four performance standards are being met three years post-construction, including total vegetative cover within the riparian zone, woody vegetation cover, and stream bank stability (Table 4). The percent cover of noxious weed species observed within the riparian zone failed to meet the success criteria of less than 10%. Photographs of photo points (Appendix B) and as-built drawings (Appendix C) have been provided as additional documentation of the site's condition in this monitoring report.

**Table 4. Performance results of North Fork Bear Creek three years following project completion.**

Monitoring Parameter	Performance Criteria	Status 3 Years Following Construction	Meeting Performance Criteria?
Riparian Cover	Greater than 50% aerial coverage of desirable perennial plants, including seeded species and those colonizing from adjacent undisturbed habitats.	Desirable cover estimated at <b>55%</b> (90% total cover - 35% weed cover).	Yes
Riparian Cover	Greater than 25% aerial coverage of woody riparian shrubs and/or trees.	Woody riparian species cover estimated at <b>30%</b> of project area	Yes
Riparian Cover	Less than 10% aerial coverage of site has Montana noxious weeds.	Noxious weed cover is estimated at <b>35%</b> of the project area.	No
Streambank Stability	Less than 25% of total bank length exhibiting signs of active erosion/cutting	Erosion inventory documented <b>0%</b> of project reach exhibits active erosion/cutting	Yes

### 5.1. Riparian Cover

Desirable perennial plants including riparian shrubs, trees, grasses, and forbs were estimated at 55% cover for the project site. This estimate was calculated by subtracting the sum of noxious weed cover (35%) and bare ground cover (10%) from 100. The monitoring criteria specify a minimum of 50% of the project reach must exhibit desirable vegetation coverage; therefore this performance criterion is currently being met.

Woody vegetation was estimated at 30% cover, which exceeds the 25% performance criteria. The majority of woody plants include shrubs and trees that existed prior to relocating the channel and volunteer species colonizing the site. Woody cuttings were planted along the left (north) bank, but have not successfully established due to inadequate installation.

Noxious weeds were estimated at 35% areal coverage of the project site, which does not meet the performance standard of less than 10% areal coverage. Three additional noxious weeds were observed in 2014 as compared to the 2013 monitoring event, bringing the total number of noxious weed species observed to eight. Identified noxious weeds include knotweed complex, broad-leaf pepperwort, spotted knapweed, Canadian thistle, field bindweed, gypsy-flower (houndstongue), oxeye daisy, and common tansy. Noxious weeds were observed along both banks of the project reach, and were primarily concentrated upstream of the Highway 93 Bridge.

## **5.2. Streambank Stability**

No streambank erosion was noted along the reconstructed banks within the North Fork Bear Creek Stream Mitigation Site. Root wads placed along the north bank appear to be mostly stable, with upper bank scour observed adjacent to one of the root wads. No lateral bank retreat was observed, and as a result, no measures are currently warranted to improve bank stability within the project reach. Monitoring of the exposed root wad is recommended to determine if that bank segment becomes unstable following future high water events.

## **6.0 MANAGEMENT RECOMMENDATIONS**

The following management recommendations were provided following the initial monitoring event in 2013; however, they remain relevant to ensuring the success of this and other mitigation sites in meeting performance standards.

### **6.1. Recommendations for installing woody cuttings**

Successfully establishing woody vegetation from un-rooted cuttings requires the cuttings be installed to a depth that allows newly established roots to reach the low water table elevation. The North Fork of Bear Creek was dry during the 2013 site visit, indicating the low water table elevation in the North Fork of Bear Creek may actually be below the stream bed elevation during some years. The channel was flowing during the 2014 site visit.

Installing woody cuttings to this depth can be very challenging, especially when the native bank materials consist of alluvial cobbles and large gravels overlain with a thin layer of topsoil. Installing riparian cuttings to the proper depth through these materials requires using either an excavator-mounted stinger or a hand-held stinger outfitted with pressurized water. Cuttings cannot be installed through alluvial cobbles properly with hand tools such as crow bars and hammers. Guidance for installing willow cuttings using excavator mounted stingers and water jet stingers is provided by the NRCS (NRCS 2007).

Monitoring observations revealed many of the cuttings were approximately 2-3" in diameter. Cutting survival and ease of installation may be improved by harvesting cuttings that are no more than 1" in diameter. It is highly recommended to harvest cuttings only while they are dormant, typically between October 15 and April 15. Following installation of un-rooted cuttings, exposed stems should be trimmed to allow

exposure of approximately 12” of the stem. This technique focuses the energy of the cutting toward establishing roots rather than leaves and stems, and improves long term survival rates.

Mortality rates of woody cuttings at the North Fork Bear Creek site may have been reduced if channel restoration details specified installing un-rooted cuttings to a depth below the lowest water table. Based on the poor survival rates encountered at this site, the alternative planting techniques described above, and the incorporation of more detailed planting specifications is recommended for future MDT projects involving bioengineered streambank stabilization projects.

### **6.2. Coir Fabric Installation**

Channel restoration details specified placing coir erosion control netting along the reconstructed streambanks to protect the upper banks from erosion during high water events. Inspections revealed the leading edge of the coir fabric was exposed after being draped over the top of the bank and staked down with wood stakes. Design details called for backfilling 4.5 feet (1.5 meters) of the leading edge of the coir, followed by wrapping the remaining coir around the fill material to create an encapsulated soil lift. It appears the contractor did not follow this procedure, as evidenced by the installation of cuttings within one foot of the edge of the exposed fabric (Photos 1 and 2, Appendix B). As constructed, the coir fabric provides little protection from soil erosion along the top of the bank, particularly along the rootwads placed upstream of the bridge. Downstream of the bridge, herbaceous vegetation has established through the coir, and is providing some degree of protection against soil losses along the upper bank.

### **6.3. Storm Water Erosion Control Materials**

Several straw logs used for stormwater erosion control were used adjacent to the bridge abutments. Remnants of some straw logs remain, with plastic webbing observed along the stream banks next to the horse corral north of the stream channel. Plastic webbing used to reinforce straw logs and woven fabrics along stream banks typically do not photo-degrade and end up as trash caught in debris jams and may act as gill nets. Straw logs and coir fabrics made with biodegradable or photodegradable materials are recommended for erosion control of future projects adjacent to stream channels. The North Fork Bear Creek project was constructed prior to MDT updating BMP specifications for erosion and storm water control to indicate the use of biodegradable materials. In addition, permits issued by both Montana FWP and the U.S. Army Corps of Engineers include conditions requiring the use of biodegradable and photodegradable materials along streams and wetlands.

### **6.4. Weed Control**

Monitoring events in both 2013 and 2014 documented relatively high occurrences of noxious weeds within the project site, resulting in an overall decline in the percent cover of desirable species. Implementation of a weed control plan at this project site would improve the likelihood of achieving the performance standards established for total vegetative cover of desirable species, and noxious weed cover. Noxious weeds were observed on both banks, and were primarily concentrated on the upstream side of the

Highway 93 Bridge. Locations of specific weed infestations are included on Figure 2 in Appendix A.

## **7.0 LITERATURE CITED**

Lichvar, R.W., M. Butterwick, N.C. Melvin, and W.N. Kirchner. 2014. The National Wetland Plant List: 2014 update of wetland ratings. *Phytoneuron* 2014-41: 1-42. Published 2 April 2014. ISSN 2153 733X

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

Natural Resources Conservation Service. 2007. How to Plant Willows and Cottonwoods for Riparian Restoration. Technical Note #23. USDA Plant Materials Center, Aberdeen, Idaho. Prepared by J. Chris Hoag.

Snook, E. 2013. Personal correspondence via 10/22/2013 email. Hydrologist, Bitterroot National Forest, Hamilton, MT.

### **Websites**

Montana State University Extension Service: 2013 MT noxious weed species list:  
<http://www.msuextension.org/invasiveplantsMangold/noxioussub.html>



## **Appendix A**

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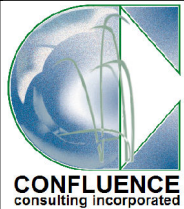
### Project Site Map

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MDT Stream Mitigation Monitoring  
North Fork Bear Creek  
Ravalli County, Montana



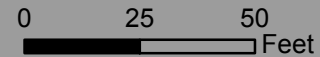
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



**Legend**

- Photo Points
- Centaurea stoebe*
- Cirsium arvense*
- Convolvulus arvensis*
- Cynoglossum officinale*
- Leucanthemum vulgare*
- Polygonum sp.*

- Tanacetum vulgare*



**2014 Monitoring  
NF Bear Creek**

Figure 2

Date: 10/29/2014

X:/MDT\_.007/mains

## **Appendix B**

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### Project Area Photos

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MDT Stream Mitigation Monitoring  
North Fork Bear Creek  
Ravalli County, Montana

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**PHOTO INFORMATION**

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATES: 2013 and 2014 Monitoring Events



**Photo Point 1.1—2013**  
**Description:** View of tributary/culvert entering from west. **Compass:** 270 (West)



**Photo Point 1.1—2014**  
**Description:** View of tributary/culvert entering from west. **Compass:** 270 (West)



**Photo Point 1.2—2013**  
**Description:** View of north streambank looking down-stream. **Compass:** 45 (Northeast)



**Photo Point 1.2—2014**  
**Description:** View of north streambank looking down-stream. **Compass:** 45 (Northeast)



**Photo Point 1.3—2013**  
**Description:** View of north streambank. **Compass:** 90 (East)



**Photo Point 1.3—2014**  
**Description:** View of north streambank. **Compass:** 90 (East)

**PHOTO INFORMATION**

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events



**Photo Point 1.4—2013**  
**Description:** View of dry channel looking upstream.  
**Compass:** 230 (Southwest)



**Photo Point 1.4—2014**  
**Description:** View of dry channel looking upstream.  
**Compass:** 230 (Southwest)



**Photo Point 2.1—2013**  
**Description:** View of root wads on north bank.  
**Compass:** 225 (Southwest)



**Photo Point 2.1—2014**  
**Description:** View upstream of root wads on north bank.  
**Compass:** 225 (Southwest)



**Photo Point 2.2—2013**  
**Description:** View across channel of south streambank.  
**Compass:** 180 (South)



**Photo Point 2.2—2014**  
**Description:** View across channel of south streambank.  
**Compass:** 180 (South)

**PHOTO INFORMATION**

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events



**Photo Point 2.3—2013**  
**Description:** View from north bank looking across channel. **Compass:** 135 (Southeast)



**Photo Point 2.3—2014**  
**Description:** View from north bank looking across channel. **Compass:** 135 (Southeast)



**Photo Point 3.1—2013**  
**Description:** View downstream from north bridge abutment. **Compass:** 90 (East)



**Photo Point 3.1—2014**  
**Description:** View downstream from north bridge abutment. **Compass:** 90 (East)



**Photo Point 3.2—2013**  
**Description:** View of south streambank from left abutment. **Compass:** 135 (Southeast)



**Photo Point 3.2—2014**  
**Description:** View of south streambank from left abutment. **Compass:** 135 (Southeast)

## PHOTO INFORMATION

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events



**Photo Point 3.3—2013**

**Description:** View across channel of south bank from north bridge abutment. **Compass:** 180 (South)



**Photo Point 3.3—2014**

**Description:** View across channel of south bank from north bridge abutment. **Compass:** 180 (South)



**Photo Point 4.1—2013**

**Description:** View from south bank looking upstream from downstream extent. **Compass:** 270 (West)



**Photo Point 4.1—2014**

**Description:** View from south bank looking upstream from downstream extent. **Compass:** 270 (West)



**Photo Point 4.2—2013**

**Description:** View of root wads on north bank downstream of bridge. **Compass:** 0 (North)



**Photo Point 4.2—2014**

**Description:** View of root wads on north bank downstream of bridge. **Compass:** 0 (North)

**PHOTO INFORMATION**

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATE: 2013 and 2014 Monitoring Events



**Photo Point 4.3—2013**  
**Description:** View of north bank from downstream extent of project site. **Compass:** 68 (East-Northeast)



**Photo Point 4.3—2014**  
**Description:** View of north bank from downstream extent of project site. **Compass:** 68 (East-Northeast)



**PHOTO INFORMATION**

PROJECT NAME: North Fork Bear Creek Stream Mitigation Site

DATE: 2014 Monitoring Event



Loss of cobbles above root wad

**Photo 1**  
**Description:** Root wads upstream of bridge.



**Photo 2**  
**Description:** Root wad upstream of bridge showing scour.



**Photo 3**  
**Description:** Underwater photo of large hole downstream of project site.



**Photo 4**  
**Description:** Underwater photo of large hole downstream of project site.



**Photo 5**  
**Description:** Large hole downstream of project site.

## **Appendix C**

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### As Built Drawings and Design Schematics

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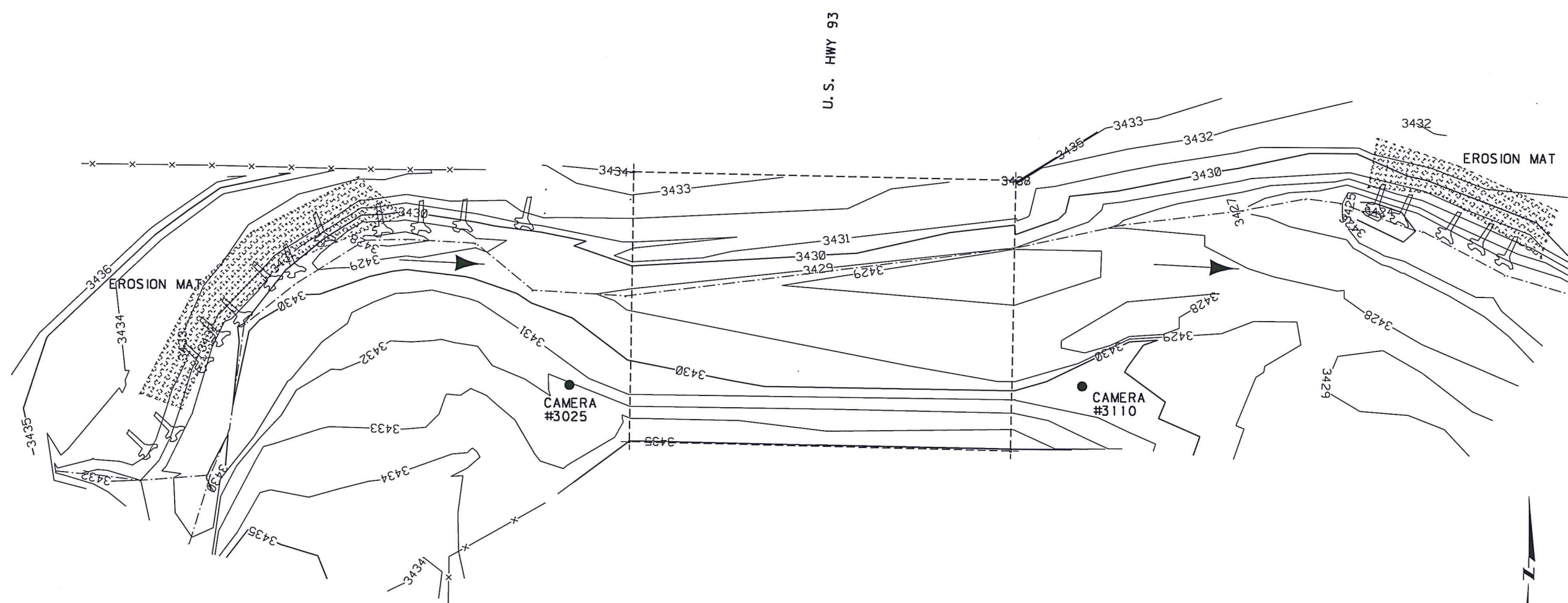
MDT Stream Mitigation Monitoring  
North Fork Bear Creek  
Ravalli County, Montana

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CONTROL TABLE				
PNT#	NORTHING	EASTING	ELEV.	DESCRIPTION
CI2015	820308.760	797947.813	3435.224	MDT AL CAP
CG2015	819805.449	798080.492	3436.854	MDT AL CAP



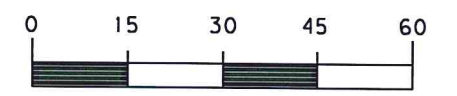
LEGEND  
 ROOT BALL



AS-BUILT TOPOGRAPHIC DRAWING OF THE NORTH FORK OF BEAR CREEK CHANNEL

SURVEYOR NOTES:

1. THIS SURVEY IS BASED ON FOUND MDT ALUMINUM CAPS STAMPED CI2015 AND CG2015 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 CI2015.
2. THE COORDINATES SHOWN HEREON ARE BASED ON MONTANA STATE PLANE GRID



3  
2  
1

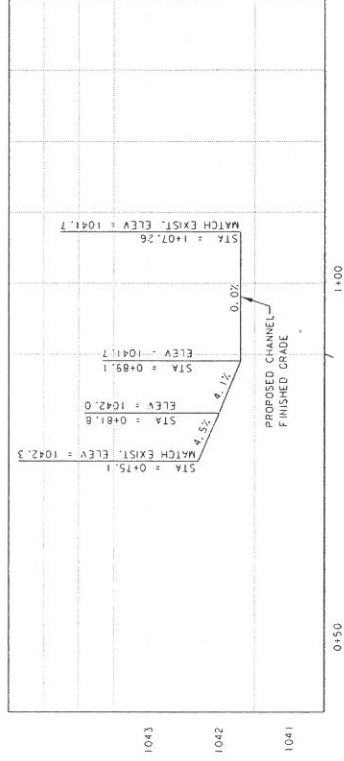
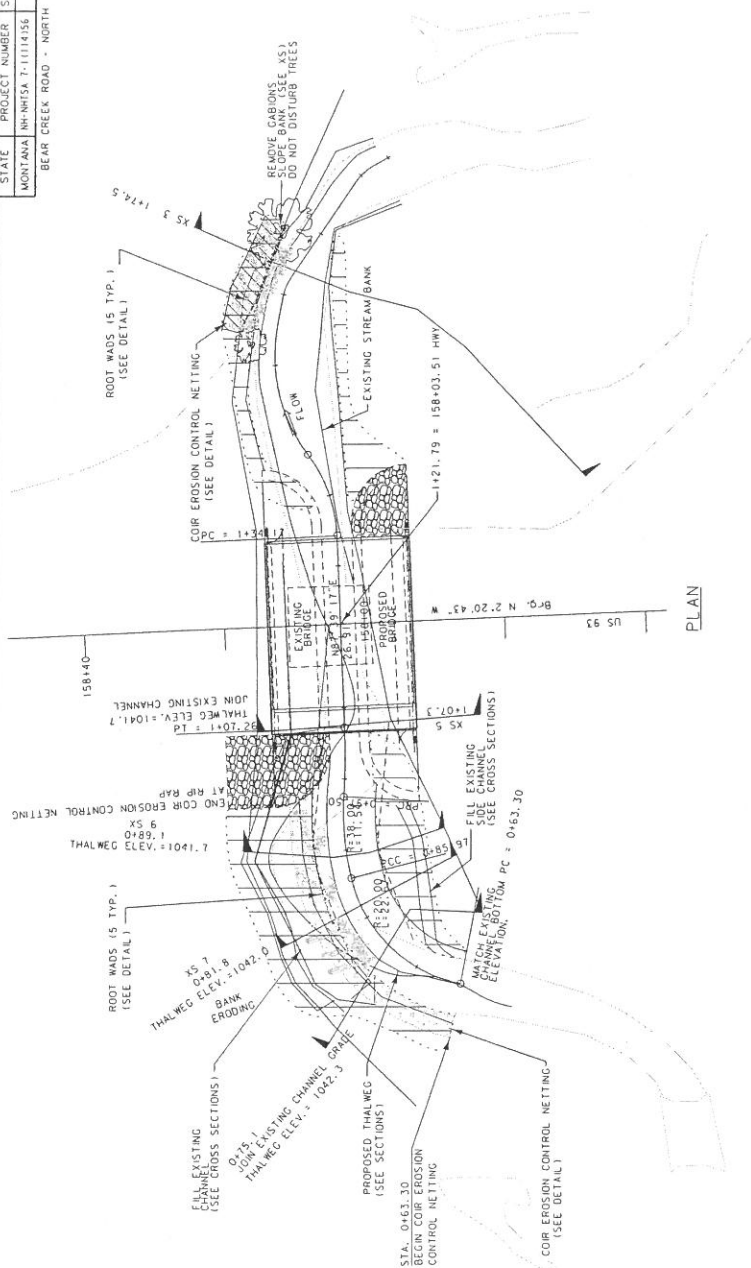
**MDT** MONTANA DEPARTMENT OF TRANSPORTATION

...NF BEAR CREEK PLAN.dgn  
 12/9/2013  
 11:02:51 AM awibe

DESIGNED BY ARNE W  
 REVIEWED BY  
 CHECKED BY LARRY R

N.F. BEAR CREEK

MDT STREAM MITIGATION MONITORING SURVEY



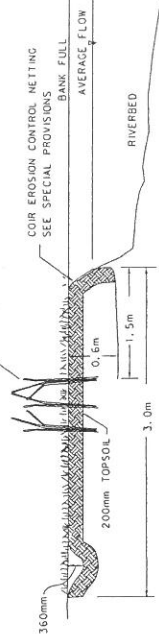
**COORDINATE TABLE**

STATION	NORTHING	EASTING
0+76.03	36,218.1167	56,132.1603
0+85.97	36,221.2271	56,204.3003
0+91.78	36,222.6477	56,210.3363
1+02.39	36,222.0482	56,221.2141
1+07.46	36,222.2420	56,226.0927
1+10.14	36,223.4034	56,226.3943
1+15.61	36,223.6668	56,222.3869
1+20.48	36,227.4917	56,224.3830
1+25.35	36,231.0305	56,226.2933
1+30.22	36,230.1936	56,227.8178
1+35.09	36,229.8772	56,229.1522
1+40.00	36,229.1764	56,230.3597
1+45.00	36,218.2584	56,304.6191
1+50.00	36,216.0744	56,305.8532

- NOTES:**
- REMOVE ALL EXISTING CARBONS, APPROXIMATE STATION 1+63 TO 1+78, AS DIRECTED BY ENGINEER.
  - INSTALL SIX (6) ROOT WAD STRUCTURES BETWEEN STATIONS 1+63 AND 1+78 AS DIRECTED BY ENGINEER.
  - INSTALL SIX (6) ROOT WAD STRUCTURES BETWEEN STATION 0+66 AND 1+10 AS DIRECTED BY ENGINEER.
  - DO NOT DISTURB EXISTING STUMPS/ROOT WADS NEAR STATION 0+90
  - DO NOT DISTURB TREES IN GABION AREA 1+78

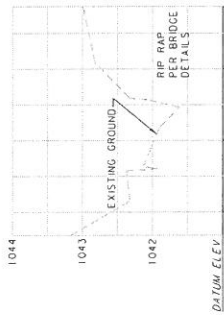


T. 8 N.R. 20 W.

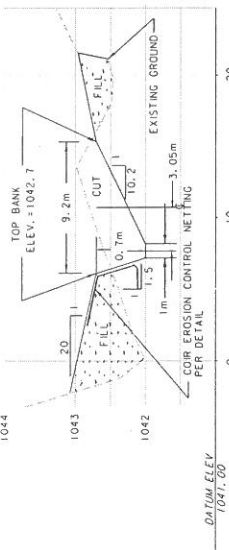


1. SUB EXCAVATE BANKS 0.6 METERS FROM EDGE OF BANK.
2. BACK FILL WITH NATIVE MATERIAL AND 0.2 METERS TOPSOIL.
3. BACK FILL WITH NATIVE MATERIAL AND 0.2 METERS TOPSOIL.
4. WRAP NETTING AND EXTEND 3.0 METERS MIN. FROM BANK EDGE.

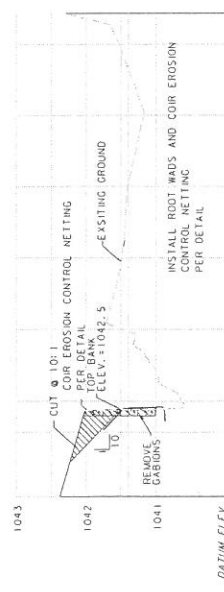
COIR EROSION CONTROL NETTING TYPICAL  
N. FORK BEAR CREEK



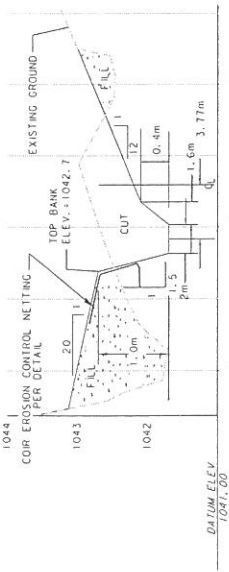
1+07.3



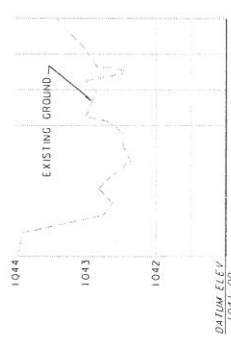
0+81.8



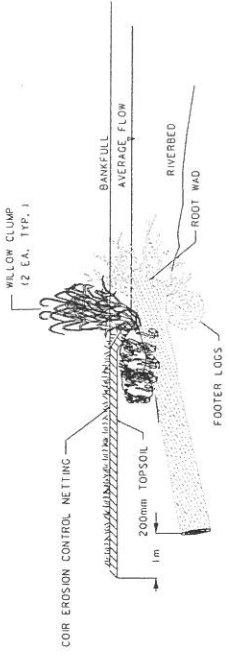
1+74.5



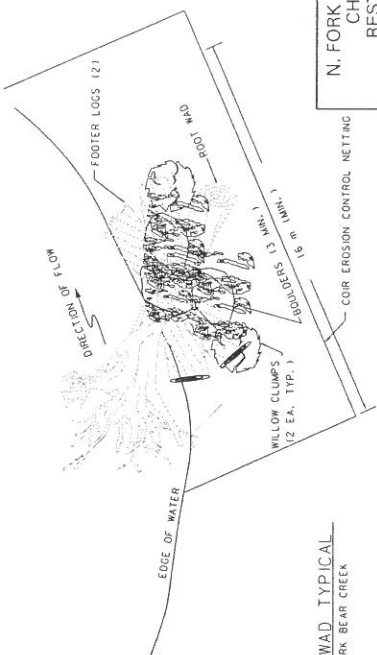
0+89.1



0+75.1



ROOT WAD TYPICAL  
N. FORK BEAR CREEK



COIR EROSION CONTROL NETTING  
PLAN

ROOT WAD TYPICAL  
N. FORK BEAR CREEK

N. FORK BEAR CREEK  
CHANNEL  
RESTORATION  
DETAILS  
STA. 158+03  
SHEET 2 OF 2  
NO SCALE