
MONTANA DEPARTMENT OF TRANSPORTATION STREAM MITIGATION MONITORING REPORT

*Clark Fork River
Granite County, Montana*

*Project Completed: 2013
Monitoring Report #4: December, 2016*



Prepared for:



Prepared by:



MONTANA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION MONITORING REPORT
YEAR 2016

Clark Fork River
Granite County, Montana

Permit No.
MFWP: SPA MDT R2-14-2012
USACE: NWO-2012-00831-MTH

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Cover Photo: 2016 view of Clark Fork River with riprap and willow plantings looking east.

1.0 INTRODUCTION

The following report presents the fourth year of monitoring results of a bank stabilization project on Interstate 90 along the Clark Fork River approximately 24 miles west of Drummond, Montana. In 2013, the Montana Department of Transportation (MDT) requested authorization for placement of approximately 200 cubic yards of rip rap along 150 linear feet of the Clark Fork River to protect Interstate 90 from bank erosion and encroachment upon the highway right-of-way. This report evaluates the monitoring results in comparison to project performance standards as required by the U.S. Army Corps of Engineers (USACE) in permit NWO-2012-00831-MTH.

The approved U.S. Army Corps 404 permit requires monitoring for three years post-construction, and outlines the following performance standards:

1. Minimum of 80 percent survival of plantings three years after planting.
2. Riprap must be covered with topsoil, seeded, and sprigged with willows above the ordinary high water mark.

Additional reporting requirements include:

1. Annual report detailing the extent of revegetation efforts and survival rates of plantings.
2. Photographs of the site prior to, during, and immediately following construction, as well as for three years post-construction, must be a part of the monitoring reports.

Inspection of the site from 2013 through 2016 provides the opportunity to determine whether the project is meeting, or moving toward the intended performance targets. MDT has met the minimum requirement of performing three years of monitoring at this site; subsequent monitoring efforts will be at the discretion of MDT and the USACE based on the site's ability to meet performance standards.

2.0 SITE LOCATION

The project site is located north of the westbound lane of Interstate 90 between mile posts 137 and 138, and is 24 miles west of Drummond, MT. The site lies within Section 24, Township 11 North, Range 15 West, Granite County, Montana (Latitude: 46.170007°N; Longitude: -113.4392°W) (Figure 1).

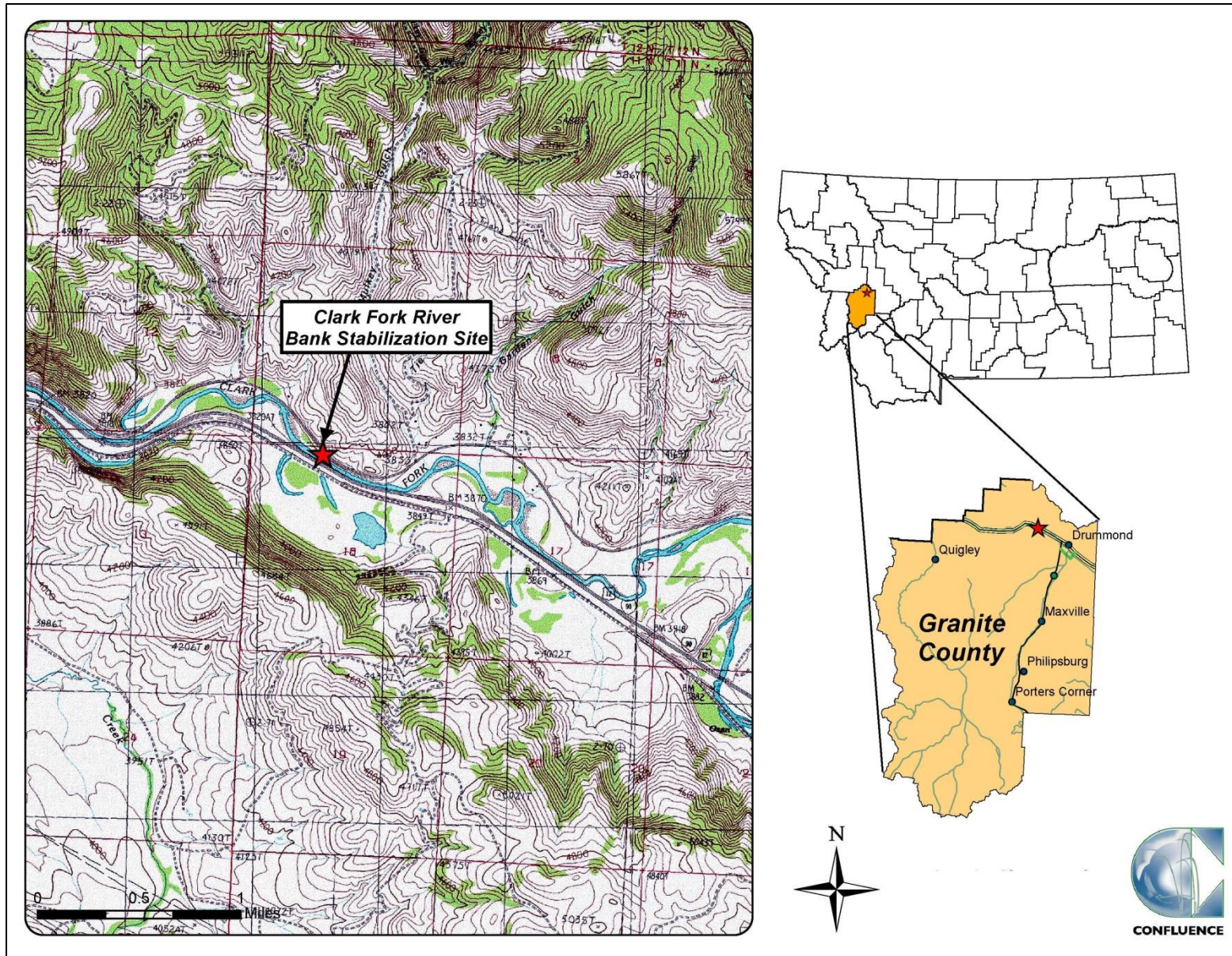


Figure 1. Project location of Clark Fork River bank stabilization site.

3.0 MONITORING METHODS

The Army Corps permit issued in 2013 requires annual monitoring of the project site to detail the extent of revegetation efforts and survival rates of plantings. The project site was monitored for the fourth time on July 25, 2016. Monitoring inspections performed in 2016 included:

- Documenting overall stability of the bank by inspecting for voids within the riprap, shifting of the riprap, and erosion upstream and downstream of the riprap,
- Recording the number of live and dead willow stems observed beneath and above the riprap to determine survival rates of planted vegetation,
- Documenting vegetation establishment throughout the site by creating a list of all vegetation species observed and noting areas of poor vegetation establishment,
- Documenting the presence of all noxious and invasive species,
- Documenting site conditions by repeating photo points established in 2013 and taking additional photographs of other notable occurrences.

These methodologies have been repeated annually to allow for a comparison of the site's condition with the performance standards while meeting all other monitoring requirements as outlined in the Army Corps permit for the project.

4.0 MONITORING RESULTS

4.1. Bank Stability

Inspection of the site for the past three years indicated minor loss of smaller sized riprap installed on the bank, likely as a result of shear forces during spring runoff events. Some of the smaller sized rock placed along the bank has either sloughed further down the bank or transported downstream, exposing several of the willow stems installed beneath the bank. All larger rock has remained in place and overall, the bank remains stable. Placement of additional rock to maintain lateral stability along the length of the stabilized bank does not appear to be warranted at this time.

Bank erosion was noted in 2014 and 2015 immediately upstream of the placed riprap. Observations in 2016 noted the bank has eroded approximately 4' further southward in the past year, exposing additional rock installed within a keyway trench (See Photo 7 in Appendix A). While the extent of the keyway into the bank is unknown, continued erosion southward at this location may eventually result in the riprap being flanked from the upstream end.

4.2. Woody Planting Establishment

Woody vegetation plantings installed during construction of the project included placement of willow cuttings above and beneath the riprap. Willow cuttings installed beneath the riprap were placed vertically with the stems set in saturated substrate, then

covered by a layer of soil and filter fabric. Rock was then placed on the fabric over the willow cuttings to secure the bank. This approach intended for willows to grow through the fabric and voids in the riprap, eventually establishing a vegetated bank. Additional willow cuttings were installed on the bank just above the riprap to serve as a buffer between the adjacent hill slope and the stabilized bank (see Photos 1, 4, 8, 9, and 10 in Appendix A). The project did not include installation of containerized plants, although some *Cornus alba* (red osier dogwood) were also observed growing above the riprap. All red osier dogwood observed were considered volunteers and were not included in the planted woody vegetation inventory.

4.2.1. Willow establishment above rip rap

Willows placed along the top of the rock were installed as vertical, unrooted sprigs. Willow sprigs along the eastern (upstream) 75' of the stabilized bank have shown limited survival and have developed into a sparse stand of shrubs spaced approximately 10-20 feet apart. The willows that have survived along the east side of the project reach since construction three years ago are maturing, have multiple stems, and have grown to a height of 5-6 feet. Along the western (downstream) 75' of the stabilized bank, many of the sprigs have successfully colonized and developed into a relatively tall stand of willows ranging from four to nine feet in height. It is unclear what factors led to more successful willow generation from sprigs along the downstream end of the project reach.

4.2.2. Willow establishment from beneath rip rap

Observations of live willows establishing from beneath the rip rap have increased over the past four monitoring events; however have thus far shown very limited survival overall. A total of 16 willow shoots were observed growing out of the rock layer in 2016, all of which are growing along the western (downstream) half of the bank (see additional photo #2 in Appendix A). No sprigs have produced leafy stems along the eastern (upstream) half of the bank. Many dead willow sprigs were observed in the rock voids, which did not appear to have adequate topsoil for roots to establish (see Additional Photo 1 on Page 5 of Appendix A). While the exact cause of high mortality rates is unknown, the low survivability willows installed beneath the riprap could be due to long inundation periods during high flows, desiccation within the riprap voids, or not having enough soil contact with roots during the first growing season.

4.2.3. Willow survival rates

Planted willow cutting survival rates were determined by dividing the number of live willows observed by the total number of willows observed. Using this method, the success rate of willow establishment is 62% above the rip rap, 21% beneath the rip rap, and 42% overall (Table 1).

Table 1. Number of live and dead willow stems observed along the Clark Fork River bank stabilization site from 2013 through 2016.

Year	Location	Total Plants Inspected	Surviving Plants	Plant Survival Rate
2013	Willows planted above riprap	345	260	75%
	Willows planted beneath riprap	0	0	N/A
	Total - 2013	345	260	75%
2014	Willows planted above riprap	275	275	100%
	Willows planted beneath riprap	52	2	4%
	Total 2014	327	277	85%
2015	Willows planted above riprap	101	67	66%
	Willows planted beneath riprap	50	11	22%
	Total 2015	151	78	52%
2016	Willows planted above riprap	81	50	62%
	Willows planted beneath riprap	76	16	21%
	Total 2016	157	66	42%

4.3. Vegetation Composition

Table 2 provides a comprehensive list of vegetation species identified at the Clark Fork River bank stabilization site. In 2016, 54 plant species were observed as compared to 49 species in 2015, 35 species in 2014, and 14 species in 2013. Woody plants establishing above the riprapped bank included *Salix exigua* (narrow-leaf willow), *Salix drummondiana* (Drummond's willow) and red-osier dogwood. In general, the vegetation composition along the river bank comprises a majority of noxious and non-native weed species that commonly occur in riparian areas that have been heavily disturbed.

Vegetation has continued to establish between the north edge of the highway and the stabilized bank (see Photos 5 and 12 in Appendix A). The same five noxious weed species observed during the 2015 monitoring event were identified during the 2016 monitoring event and are summarized in Table 3. All noxious weed species were identified in trace to low amounts, which is defined as infestations covering less than 1% and 1-5% of the inspected area, respectively.

Table 2. Comprehensive list of plant species identified at the Clark Fork River site from 2013 through 2016.

Scientific Name	Common Name	WMVC Indicator Status*	Scientific Name	Common Name	WMVC Indicator Status*
<i>Agropyron cristatum</i>	Crested Wheatgrass	NL	<i>Melilotus officinalis</i>	Yellow Sweet-Clover	FACU
<i>Agrostis stolonifera</i>	Spreading Bent	FAC	<i>Onopordum acanthium</i>	Scotch Thistle	NL
<i>Alopecurus arundinaceus</i>	Creeping Meadow-Foxtail	FAC	<i>Panicum capillare</i>	Common Panic Grass	FAC
<i>Bassia scoparia</i>	Mexican-Fireweed	FAC	<i>Pascopyrum smithii</i>	Western-Wheat Grass	FACU
<i>Bromus inermis</i>	Smooth Brome	UPL	<i>Persicaria amphibia</i>	Water Smartweed	OBL
<i>Bromus tectorum</i>	Cheatgrass	NL	<i>Phalaris arundinacea</i>	Reed Canary Grass	FACW
<i>Chenopodium album</i>	Lamb's-Quarters	FACU	<i>Phleum pratense</i>	Common Timothy	FAC
<i>Cirsium vulgare</i>	Bull Thistle	FACU	<i>Poa palustris</i>	Fowl Blue Grass	FAC
<i>Cirsium arvense</i>	Canadian Thistle	FAC	<i>Poa pratensis</i>	Kentucky Blue Grass	FAC
<i>Cornus alba</i>	Red Osier	FACW	<i>Polygonum aviculare</i>	Yard Knotweed	FAC
<i>Dactylis glomerata</i>	Orchard Grass	FACU	<i>Populus angustifolia</i>	Narrow-Leaf Cottonwood	FACW
<i>Dasiphora fruticosa</i>	Golden-Hardhack	FAC	<i>Pseudoroegneria spicata</i>	Bluebunch Wheatgrass	NL
<i>Descurainia sophia</i>	Herb Sophia	NL	<i>Rumex crispus</i>	Curly Dock	FAC
<i>Elymus repens</i>	Creeping Wild Rye	FAC	<i>Salix drummondiana</i>	Drummond's Willow	FACW
<i>Elymus trachycaulus</i>	Slender Wild Rye	FAC	<i>Salix exigua</i>	Narrow-Leaf Willow	FACW
<i>Epilobium ciliatum</i>	Fringed Willowherb	FACW	<i>Salix lasiandra</i>	Pacific Willow	FACW
<i>Equisetum hyemale</i>	Tall Scouring-Rush	FACW	<i>Silene noctiflora</i>	Night-flowering Catchfly	NL
<i>Euphorbia esula</i>	Leafy Spurge	NL	<i>Sinapis arvensis</i>	Corn Mustard	NL
<i>Festuca idahoensis</i>	Bluebunch Fescue	FACU	<i>Sisymbrium altissimum</i>	Tall Hedge-Mustard	FACU
<i>Festuca ovina</i>	Sheep Fescue	UPL	<i>Sonchus arvensis</i>	Field Sow-Thistle	FACU
<i>Helianthus annuus</i>	Common Sunflower	FACU	<i>Symphoricarpos occidentalis</i>	Western Snowberry	FAC
<i>Hordeum jubatum</i>	Fox-Tail Barley	FAC	<i>Tanacetum vulgare</i>	Common Tansy	FACU
<i>Lactuca serriola</i>	Prickly Lettuce	FACU	<i>Thlaspi arvense</i>	Field Pennycress	UPL
<i>Lepidium campestre</i>	Field Pepper-Grass	NL	<i>Tragopogon dubius</i>	Meadow Goat's-beard	NL
<i>Lepidium perfoliatum</i>	Clasping Pepperwort	FACU	<i>Trifolium pratense</i>	Red Clover	FACU
<i>Leucanthemum vulgare</i>	Ox-Eye Daisy	FACU	<i>Trifolium repens</i>	White Clover	FAC
<i>Linaria dalmatica</i>	Dalmatian Toadflax	NL	<i>Verbascum thapsus</i>	Great Mullein	FACU

*Based on 2016 NWPL (Lichvar *et al.*, 2016)
New species identified in 2016 are **bolded**.

Table 3. Montana State listed noxious weed species observed in 2016 at the Clark Fork River bank stabilization site.

Category*	Scientific Name	Common Name
Priority 2B	<i>Cirsium arvense</i>	Canada Thistle
	<i>Euphorbia esula</i>	Leafy Spurge
	<i>Linaria dalmatica</i>	Dalmatian Toadflax
	<i>Leucanthemum vulgare</i>	Ox-Eye Daisy
	<i>Tanacetum vulgare</i>	Common Tansy

*Based on the Montana Dept. of Agriculture's Noxious Weed List, July 2015

4.4. Photo Documentation

Photographs were taken at the upstream and downstream extents, and several additional areas within the project area to document the installed bank protection measures and the extent and density of vegetation establishment along the riprap and within the project staging area adjacent to Interstate 90. Photographs taken in 2013 and 2016 are included in Appendix A.

5.0 COMPARISON OF RESULTS TO PERFORMANCE STANDARDS

Monitoring of the Clark Fork River bank stabilization site is intended to document whether the project is meeting performance standards outlined in the permits issued for project construction. The fourth year of monitoring indicates one of two performance standards are being met four years post-construction (Table 4).

Table 4. Performance results of Clark Fork bank stabilization project four years following construction.

Parameter	Success Criteria	Status	Meeting Performance Criteria?
Woody planting survival	Minimum of 80% survival of plantings three years after planting.	42% of observed woody plantings have survived	No
Construction detail	Riprap must be covered with topsoil, seeded, and sprigged with willows above the ordinary high water mark.	Riprap has been covered with topsoil, seeded, and sprigged with willows above the ordinary high water mark	Yes

5.1. Woody Planting Survival

The observed woody planting survival within the project reach was 42%, which does not meet the target performance standard of 80% four years following installation. Observed survival of woody plantings installed above the riprap was 62%, most of which have established along the western end of the project reach. Although a greater number of willows have been observed sprouting from beneath the riprap each year, they continue to show poor survival rates, with 21% of those observed having established leafy stems.

Although willow survival rates are lower than desired, the bank has remained stable in areas where rock has been installed. Placement of additional willows within the revetment is possible with specialized equipment capable of penetrating through voids in large rock; however, this could also result in reducing the cohesion of the riprap protecting the bank and jeopardize the bank's stability. Adding additional willows is not expected to increase the overall stability of the bank.

5.2. Construction Details

The area above the riprap has been reclaimed by seeding and sprigging woody cuttings through a layer of topsoil. This area exhibits woody and herbaceous establishment as indicated by maturation of surviving willows and forbs. Weed management efforts should reduce the potential for colonization by new species and spread of those currently inhabiting the site.

6.0 MONITORING SUMMARY

The Clark Fork River bank stabilization site has been monitored for four years following construction of the project in 2013. Overall, stabilization efforts along the project reach appear largely successful with some loss of the smaller sized fraction of bank protection

materials along the top of the bank. Erosion immediately upstream of the stabilized bank has continued to expose the rip rap installed at the upper end of the project reach, and should be observed to ensure the rock is not flanked by the river. If the bank continues to erode, placement of additional riprap may be recommended to maintain protection of the highway. If necessary, the extent of additional riprap installation should be evaluated based on anticipated erosive activity, flow direction, bar formation, existing bank materials, and vegetation composition.

Woody vegetation has established above the rock, particularly along the western half of the project reach. Willows along this area have grown up to nine feet in height and are likely to continue growing as they mature. Woody vegetation placed beneath the riprap during construction has shown limited success overall, although more live stems were observed in 2016 than during previous monitoring events.

Although the site has not met the performance standard for woody survival, the justification of installing additional woody plantings within the rock revetment should be weighed against the potential for destabilizing the bank. Specialized willow planting equipment such as stingers exist that is capable of installing willow sprigs in previously placed riprap (NRCS 2007); however caution should be taken while using this type of equipment to prevent the destabilization of the rock layer. If this technique is implemented, a qualified contractor with experience installing plants in riprap is recommended.

7.0 LITERATURE CITED

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. *The National Wetland Plant List. 2016 Update of Wetland Ratings*. Phytoneuron 2016-30: 1-17. Published 28 April 2016. ISSN 2153 733X

Montana Department of Agriculture. *Montana Noxious Weed List*. July 2015. Accessed September 2016 at: <http://agr.mt.gov/agr/Programs/Weeds/PDF/2015WeedList.pdf>.

Appendix A

Project Site Photos

MDT Stream Mitigation Monitoring
Clark Fork River
Granite County, Montana

PHOTO INFORMATION

PROJECT NAME: Clark Fork Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events

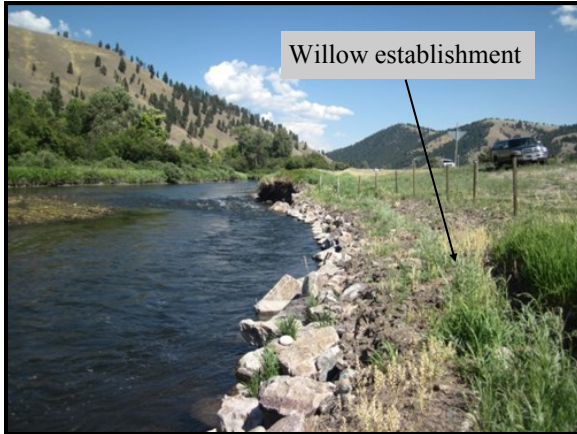


Photo 1
Description: View upstream looking at revetment.
Taken in 2013



Photo 1
Description: View upstream looking at revetment.
Taken in 2016



Photo 2
Description: Toe of revetment looking upstream.
Taken in 2013



Photo 2
Description: Toe of revetment looking upstream.
Taken in 2016



Photo 3
Description: Middle of revetment looking upstream.
Taken in 2013



Photo 3
Description: Middle of revetment looking upstream.
Taken in 2016

PHOTO INFORMATION

PROJECT NAME: Clark Fork Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events



Photo 4
Description: Willow growth at top of revetment.
Taken in 2013



Photo 4
Description: Willow growth at top of revetment.
Taken in 2016



Photo 5
Description: Highway embankment / access area.
Taken in 2013



Photo 5
Description: Weedy streambank/work area.
Taken in 2016



Photo 6
Description: Sandbar willow growth and bare ground.
Taken in 2013



Photo 6
Description: Sandbar willow growth .
Taken in 2016

PHOTO INFORMATION

PROJECT NAME: Clark Fork Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events



Photo 7
Description: Eroding streambank at upstream extent.
Taken in 2013



Photo 7
Description: Eroding streambank at upstream extent.
Taken in 2016



Photo 8
Description: Middle of revetment looking downstream.
Taken in 2013



Photo 8
Description: Middle of revetment looking downstream.
Taken in 2016



Photo 9
Description: Looking downstream at revetment.
Taken in 2013



Photo 9
Description: Looking downstream at revetment.
Taken in 2016

PHOTO INFORMATION

PROJECT NAME: Clark Fork Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events



Photo 10
Description: Close-up of sandbar willow growth.
Taken in 2013



Photo 10
Description: Close-up of sandbar willow growth.
Taken in 2016



Photo 11
Description: Upstream extent of rip-rapped stream-bank.
Taken in 2013



Photo 11
Description: Upstream extent of rip-rapped stream-bank.
Taken in 2016



Photo 12
Description: Highway embankment adjacent to bank.
Taken in 2013



Photo 12
Description: Highway embankment adjacent to bank.
Taken in 2016

PHOTO INFORMATION

PROJECT NAME: Clark Fork Stream Mitigation Site

DATE: 2013 and 2016 Monitoring Events



Photo 13
Description: Looking downstream at revetment
Taken in 2013



Photo 13
Description: Looking downstream at revetment.
Taken in 2016



Additional Photo 1
Description: Dead willows in revetment
Taken in 2016



Additional Photo 2
Description: Willow growing in revetment
Taken in 2016