FUTURE FISHERIES IMPROVEMENT PROGRAM GRANT APPLICATION

All sections must be addressed, or the application will be considered invalid

I. APPLICANT INFORMATION

A. Applicant Name: Karen Knudsen - Clark Fork Coalition

Mailing Address: PO Box 7593

City: Missoula State: MT Zip: 59807

Telephone: 406-543-0539 E-mail: karen@clarkfork.org

B. Contact Person (if different than applicant): Adam Switalski, Project Manager – Clark Fork Coalition

Address: PO Box 7593

City: Missoula State: MT Zip: 59807

Telephone: 406-396-1941 E-mail: adam@clarkfork.org

C. Landowner and/or Lessee Name (if different than applicant): Tom and Donna Leik

Mailing Address: 10832 Miller Creek Road

City: Missoula State: MT Zip: 59803

Telephone: 406-370-5853 E-mail: tleikmt@gmail.com

II. PROJECT INFORMATION

A. Project Name: Leik Property - Miller Creek Restoration

River, stream, or lake: Miller Creek

Location: Township: 12N Range: 19W Section: 23, 26

Latitude: 113.9588 Longitude: 46.7765 *Within project (decimal degrees)*

County: Missoula County

B. Purpose of Project:

The purpose of this project is to increase aquatic habitat diversity, increase riparian woody vegetation cover, reduce fine sediment inputs, and increase floodplain connectivity and function on Miller Creek. These actions are expected to increase trout carrying capacity and population resilience. Actions are also intended to reduce sediment inputs and moderate stream temperatures on Miller Creek through restoration of the riparian corridor. This project builds upon more than 2 miles of stream restoration work in Miller Creek and is a collaboration among the Clark Fork Coalition, Montana Fish, Wildlife and Parks, the Montana Department of Environmental Quality, and a private land owner.

C. Brief Project Description (attach additional information to end of application). Please include the anticipated construction schedule:

The Clark Fork Coalition and project partners are proposing a restoration project on Miller Creek that improves natural stream function, enhances fish habitat and addresses the creek's TMDLs for temperature and sediment. Miller Creek is located in Missoula County, and flows west for 18 miles from the Sapphire Mountains to its confluence with the Bitterroot River near the city of Missoula. The watershed encompasses 48 square miles and supports a variety of land uses, from silviculture and agriculture to residential subdivisions. This project builds upon more than 2 miles of completed upstream habitat restoration work.

The Leik Property Restoration Project is a collaborative partnership among the Clark Fork Coalition, Montana Fish, Wildlife and Parks, the Montana Department of Environmental Quality, and a private land owner. The project is on a perennial section of Miller Creek and includes the confluence of Miller and Inez Creek - a tributary with a genetically pure westslope cutthroat population. This project will address a series of impairments that limit fishery and water quality potential. Future Fisheries was a partner on successful projects on the upstream Spooner Creek Ranch, MPG Ranch, and the Wustner property, and we anticipate similar improvements on this project that benefit native Westslope cutthroat trout and other trout species.

This project reach is characterized by disturbed conditions from road construction, channel straightening, removal of riparian vegetation, and decreased beaver activity. This reach is bounded by the road and terraced pasture in the upstream end and a steep hillside and developed pasture in the downstream end. Habitat is simplified due to the straightened planform and entrenchment, but some pools are present. There are several actively eroding streambanks contributing sediment to the channel. Woody riparian vegetation is present along some of the channel and in some depositional areas, but streambanks and the riparian area consist primarily of introduced pasture grasses. Fish habitat issues include increased fine sediment delivery to the channel, reduced aquatic habitat diversity, and reduced riparian vegetation and cover - all of which contribute to overall degraded conditions in the project area.

In order to improve conditions in this reach and the overall stream system, Geum Environmental Consulting and project partners collaborated in project design to address the aforementioned limiting factors, improve fish carrying capacity, and mitigate riparian, temperature, sediment, and aquatic resource concerns (see attached 30% design). Specific project components include diversifying channel plan form and realigning it away from the eroding banks, grading and elevation controls to increase floodplain connectivity, large wood/debris matrix installations and other features to increase instream habitat complexity, and large scale riparian planting (with fencing) to facilitate recovery of a native riparian community. Overall, the project is designed to reduce sediment delivery to the stream, promote riparian recovery, increase floodplain connectivity and function, and increase habitat complexity that resembles unimpacted reference reach conditions.

Construction is anticipated to begin in fall 2024.

D. What was the cause of habitat degradation and how will the project correct the cause?

Past land management and channel manipulation resulted in a modified stream and riparian environment. These changes manifested in reduced trout densities, simplified habitat, increased sediment loads and an elevated temperature regime. Project objectives and planned treatments described above directly address these impacts, in concert with changes in land management.
With changes in land ownership and management, many of the current and potential impacts have been reduced and opportunities for restoration have emerged. We hope that this project and adjacent work in the upper watershed will collectively improve conditions for fisheries and concurrently address other impairments (e.g., temperature and sediment TMDLs).

E. Length of stream or size of lake that will be treated (project extent): 1,750

Length/size of impact, if larger than project extent (e.g., stream miles opened):

F. Project Budget Summary:

Grant Request (Dollars):	**$**	69,790.00
Matching Dollars:	**$**	120,675.00
Matching In-Kind Services:*	**$**	6,975.00

**salaries of government employees are not considered matching contributions*

Other Contributions (not part of this app)	**$**	
Total Project Cost:	**$**	197,440.00

G. Attach itemized (line item) budget – *see budget template*

H. Attach project location map(s) that include:

- [■] Extent of the project, including context (relation to major landmark or town)
- [■] Indication of public and private property
- [■] Riparian buffer locations and widths (if applicable) and grazing locations

I. Attach project plans:

- [■] Detailed sketches or plan views with the location and proposed restoration
- [■] Pre-project photographs (GPS location strongly recommended)
- [ ] If water leasing or water salvage is involved, attach a supplemental questionnaire (*https://myfwp.mt.gov/getRepositoryFile?objectID=36110*)

J. Attach letters or statements of support (e.g., landowner consent, community or public support, and FWP fisheries support). List any other project partners:

This project is a Collaboration among the Clark Fork Coalition, Montana Fish, Wildlife and Parks, the Montana Department of Environmental Quality, and a private land owner. We have attached letters of support from the landowner and the Missoula Valley Water Quality District. Fish Wildlife and Parks is also a supporter of the project, but a letter was not attained in time for this proposal.

III. MAINTENANCE AND MONITORING (attach additional information to end of application):

A. A 20-year maintenance commitment is required*. Please confirm that you will ensure this protection and describe your approach. Attach any relevant maintenance plans. Yes [■] No [ ]

**If it is a water leasing project, describe the length of the agreement.*

The landowner has indicated he is committed to this project, including land management changes that correct impacts associated with previous owners. This commitment includes installation of livestock exclosure fencing to protect riparian improvements/investments, donation of materials for construction, and support of monitoring and maintenance requirements. CFC will have a signed landowner agreement formalizing these commitments for a 20 year period before starting project implementation.

B. Will grazing be part of or adjacent to the project? If so, describe or attach land management plans, including short term and long term grazing regimes. If the landowner is not the applicant, please describe their involvement in the project. *If you want assistance with grazing plan development, note your need.*

The landowner is using his property as a small-scale horse boarding operation. Most of Miller Creek riparian area is already fenced except a hardened ford. As as part of the project, much of the fencing will be replaced with electric fencing and moved further away from the stream. In order to protect the project from horses, we will narrow and fence the hardened crossing/water gap.

C. Will the project be monitored to determine if goals were met? If so, what are the short-term and long-term plans to assess benefits and lessons learned? Were pre-project data collected? Will monitoring information be shared with FWP?

The Clark Fork Coalition and partners will collect extensive pre- and post- implementation monitoring. MT FWP will electro fish the reach before and after the treatments to identify changes in fish population and composition. Bank erosion hazard index (BEHI) will be collected to measure the degree of bank erosion and sediment delivery to the stream. Photo point monitoring will occur on each major restoration feature (channel realignment, large wood habitat structure, step pool structures). Plant mortality counts on installed woody riparian container stock. Additionally, CFC will lead community science teams to measure riparian recovery with the Forest Service greenline protocol, record in-stream habitat with the Forest Service R1R4 protocol, and conduct noxious weed surveys.

IV. PROJECT BENEFITS (attach additional information to end of application):

A. What species of fish will benefit from this project?

Miller Creek and its tributaries support westslope cutthroat trout and brook trout. Oncorhynchus spp. populations have a high westslope cutthroat trout genetic contribution, with Inez Creek tributary populations testing 'pure' (nonhybridized).

B. How will the project protect or enhance wild fish habitat?

The project will enhance wild fish habitat by:

- Enhancing instream habitat complexity and cover
- Increasing connectivity between the channel and the floodplain.
- Increasing width and quality of riparian corridor, with enhanced woody vegetative cover.
- Protecting the stream corridor, channel and overall investment from future impacts
- Reducing fine sediment delivery to the channel with enhanced buffer and channel stability

C. What is the expected improvement to fish populations, both short term and long term? How might the project translate to angler success?

Miller Creek is one of three primary tributaries within the lower Bitterroot River system that provide trout recruitment to the fishery. Although Miller Creek is primarily a stream-resident, wild trout fishery in middle and upper reaches with intermittency in lower reaches, it does provide recruitment to the river during spring high flow periods. The lower Bitterroot River is a recruitment-limited fishery with intense fishing pressure (Ladd Knotek, FWP).
Middle reaches of the stream where this project takes place are also a local fishery resource in terms of high trout densities and high conservation value for native cutthroat trout. Connection of these projects/reaches with important river reaches will only improve as projects are completed and connectivity is restored.

D. Will the project increase public fishing opportunity for wild fish and, if so, how? Is public fishing allowed onsite? If not, describe how the public would access the project benefits.

This project will increase trout carrying capacity in an middle reach of main stem Miller Creek. Through this project and those already completed and planned in Miller Creek, we hope to increase recruitment to the Bitterroot River and enhance opportunity for the thousands of anglers that recreate there.
As mentioned above, there is also a local fisheries benefit as trout abundance/carrying capacity is significantly increased in project reaches similar to that proposed. Although the property is private, anglers can access the stream just upstream of the project on DNRC lands.

E. Aside from angling, what local or large-scale public benefits will be realized from this project?

Public benefits include increased fish carrying capacity, improved water quality, increased instream habitat and riparian habitat complexity benefitting a range of wildlife species, enhanced trout recruitment and fishing opportunity on Miller Creek and the Bitterroot River.

F. Will the project interfere with water or property rights of adjacent landowners? (explain):

No. This project will not interfere with the water supply, water rights, or property rights of adjacent landowners. There are no water rights issues involved with this project.

G. Will the project result in the development of commercial recreational use on the site (including paid access)? Explain:

No, there is no planned development of commercial recreational use at this project site.

H. Is this project associated with the reclamation of past mining activity?

No, the project is not associated with the reclamation of past mining activities.

Each approved project applicant must enter into a written agreement with Montana Fish, Wildlife & Parks specifying terms and duration of the project. The applicant must obtain all applicable permits prior to project construction. A competitive bid process must be followed when using State funds.

V. AUTHORIZING STATEMENT

I (we) hereby declare that the information and all statements to this application are true, complete, and accurate to the best of my (our) knowledge and that the project or activity complies with rules of the Future Fisheries Improvement Program.

Applicant Signature: Karen Knudsen Digitally signed by Karen Knudsen Date: 2023.11.14 17:54:31 -07'00' Date: _____

Submittal: **Applications must be signed and received on or before November 15 and May 15 to be considered for the subsequent funding period**. Late or incomplete applications will be rejected.

Mail to:	FWP Future Fisheries Fish Habitat Bureau PO Box 200701 Helena, MT 59620-0701	Email:	Future Fisheries Coordinator FWPFFIP@mt.gov (electronic submissions must be signed) For files over 10MB, use https://transfer.mt.gov and send to mmcgree@mt.gov

BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS

Both tables must be completed or the application will be returned

PROJECT COSTS					CONTRIBUTIONS			
WORK ITEMS (Itemize by Category)	**NUMBER OF UNITS**	**UNIT DESCRIPTION***	**COST/UNIT**	**TOTAL COST**	**FUTURE FISHERIES REQUEST**	**MATCH (Cash or Services)****	**OTHER (Not part of this application)**	**TOTAL**
Personnel***								
Survey	26	hours	$ 115.00	$ 2,990.00		$ 2,990.00		$ 2,990.00
Design	95	hours	$ 115.00	$ 10,925.00		$ 10,925.00		$ 10,925.00
Engineering (develop hydraulic model, engineering compliance report)	1	LS	$ 15,000.00	$ 15,000.00		$ 15,000.00		$ 15,000.00
Wetland delineation	11	hours	$ 110.00	$ 1,210.00		$ 1,210.00		$ 1,210.00
Permitting	40	hours	$ 115.00	$ 4,600.00		$ 4,600.00		$ 4,600.00
Geum Oversight	130	hours	$ 115.00	$ 14,950.00		$ 14,950.00		$ 14,950.00
CFC Project Management (Oversight, outreach, volunteer coordination)	400	hours	$ 50.00	$ 20,000.00		$ 20,000.00		$ 20,000.00
CFC Maintenance Technician (watering for 2 years)	80	hours	$ 25.00	$ 2,000.00		$ 2,000.00		$ 2,000.00
			Sub-Total	$ 71,675.00	$ -	$ 71,675.00	$ -	$ 71,675.00
Travel								
Mileage	600		$0.655	$ 393.00		$ 393.00		$ 393.00
Per diem				$ -				$ -
			Sub-Total	$ 393.00	$ -	$ 393.00	$ -	$ 393.00
Construction Materials****								
trees/rootwads (in-kind from landowner)	60	each	$ 100.00	$ 6,000.00		$ 6,000.00		$ 6,000.00
Rock (6 in)	50	CY	$ 40.00	$ 2,000.00	$ 2,000.00			$ 2,000.00
Rock (24-36")	130	each	$ 60.00	$ 7,800.00	$ 5,000.00	$ 2,800.00		$ 7,800.00
Containerized Woody Plants	100	each	$ 15.00	$ 1,500.00		$ 1,500.00		$ 1,500.00
Native seed	50	PLS pounds	$ 10.00	$ 500.00		$ 500.00		$ 500.00
fencing	1958	linear feet	$ 5.00	$ 9,790.00		$ 9,790.00		$ 9,790.00
				$ -				$ -
				$ -				$ -
			Sub-Total	$ 27,590.00	$ 7,000.00	$ 20,590.00	$ -	$ 27,590.00
Equipment, Labor, and Mobilization								
Mobilization and Demobilization	1	Lump Sum	$ 8,000.00	$ 8,000.00	$ 8,000.00	$ -		$ 8,000.00
Water Management	1	Lump Sum	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ -		$ 2,000.00
Operated large excavator with thumb (acquire wood/brush)	40	Hours	$ 175.00	$ 7,000.00	$ 7,000.00	$ -		$ 7,000.00
Channel Realignment/Construction	463	Linear Feet	$ 17.00	$ 7,871.00	$ 7,871.00	$ -		$ 7,871.00
Side Channel Construction	304	Linear Feet	$ 14.00	$ 4,256.00	$ 4,256.00	$ -		$ 4,256.00
Woody Brush Matrix Streambank Treatment	1,076	Linear Feet	$ 15.00	$ 16,140.00	$ 11,763.00	$ 4,377.00		$ 16,140.00
Woody Brush Matrix Streambank Treatment - Side Channel	553	Linear Feet	$ 12.00	$ 6,636.00	$ 4,000.00	$ 2,636.00		$ 6,636.00
Large Woody Debris Structure	14	Each	$ 700.00	$ 9,800.00	$ 7,000.00	$ 2,800.00		$ 9,800.00
Willow Brush Trench	825	Linear Feet	$ 6.00	$ 4,950.00	$ 3,000.00	$ 1,950.00		$ 4,950.00
Step Pool Structure	3	Each	$ 750.00	$ 2,250.00	$ 1,500.00	$ 750.00		$ 2,250.00
Haul Excess Material to Repository	1,560	Cubic Yards	$ 8.00	$ 12,480.00	$ 6,000.00	$ 6,480.00		$ 12,480.00
Floodplain Grading and Roughness Treatment	0.3	Acres	$ 2,500.00	$ 750.00	$ 400.00	$ 350.00		$ 750.00
Acquire Willow cuttings for Streambank Treatments	13,674	Each	$ 1.00	$ 13,674.00		$ 13,674.00		$ 13,674.00
Install Containerized Woody Plants (volunteers)	100	Each	$ 5.00	$ 500.00		$ 500.00		$ 500.00
Install Wire Cage (volunteers)	50	Each	$ 8.00	$ 400.00		$ 400.00		$ 400.00

(Revised 11/15/2023)

Apply Seed (volunteers)	1	Acre	$ 75.00	$ 75.00		$ 75.00		$ 75.00
Weed spray (2 applications)	1	LS	$ 1,000.00	$ 1,000.00		$ 1,000.00		$ 1,000.00
			Sub-Total	$ 97,782.00	$ 62,790.00	$ 33,917.00	$ -	$ 97,782.00
			TOTALS	$ 197,440.00	$ 69,790.00	$ 126,575.00	$ -	$ 197,440.00

OTHER REQUIREMENTS:

All of the columns in the budget table and the matching contribution table MUST be completed appropriately or the application will be invalid. Please see the example budget sheet for additional clarification.

*Units = feet, hours, inches, etc. Do not use lump sum unless there is no other way to describe the costs.
**Can include in-kind materials. Justification for in-kind labor (e.g. hourly rates used). Do not use government salaries as match. Describe here or in text.

***The Review Panel suggests that design and oversight costs associated with a proposed project not exceed 15% of the total project budget. If design and oversight costs are in excess of 15%, applications may require a justification or minimum of two competitive bids for the cost of undertaking the project. For projects that include a maintenance request, it must not exceed 10% of the total project cost.

****The Review Panel recommends a maximum fencing cost of $1.50 per foot. Additional costs may be the responsibility of the applicant and/or partners.

Additional details:

APPLICATION MATCHING CONTRIBUTIONS

(do not include requested funds or contributions not associated with the application)

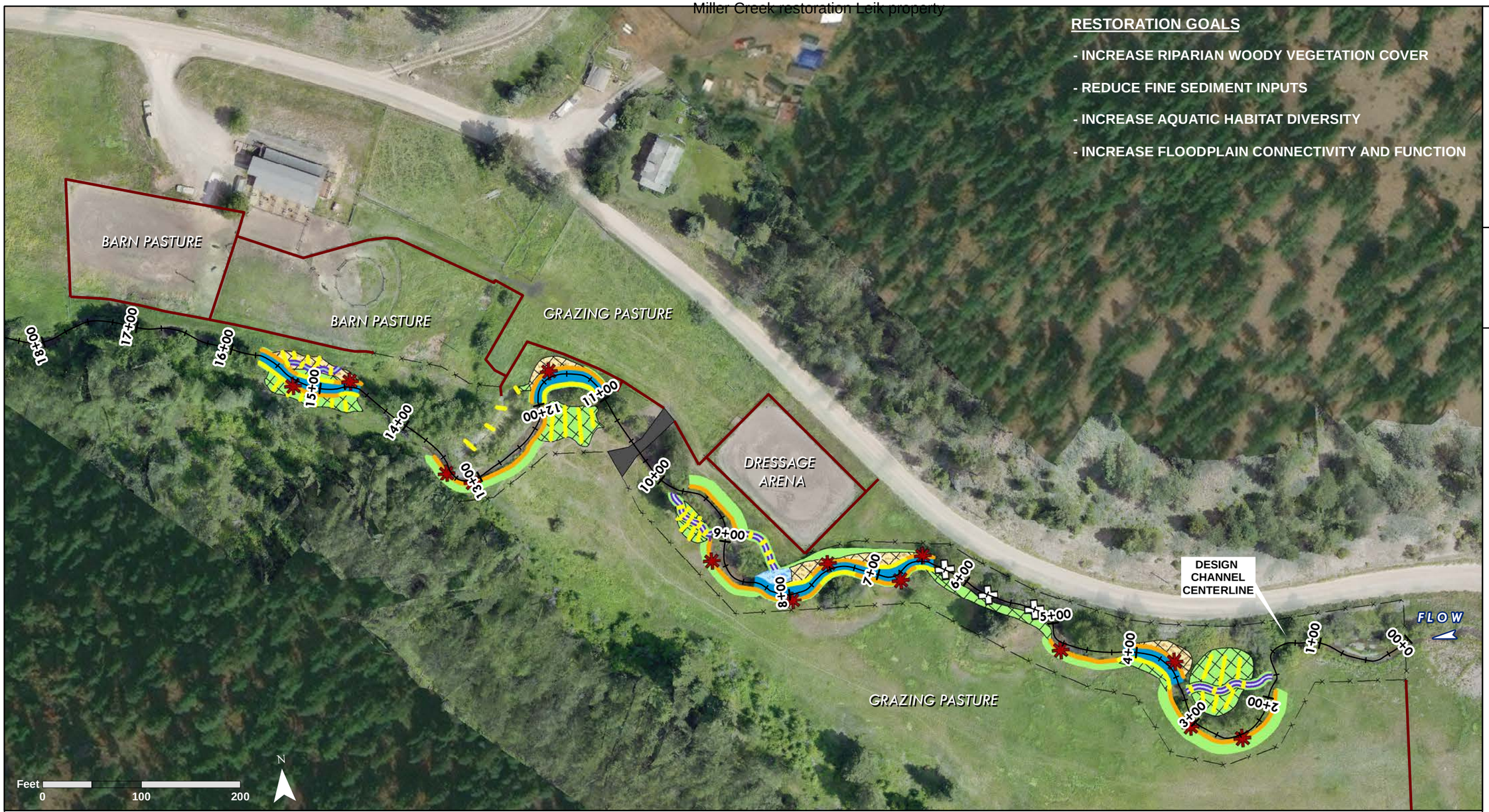
CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
Montana Department of Environmental Quality	$ -	$ 74,000.00	$ 74,000.00	yes
Montana Department of Environmental Quality (supplemental funding)	$ -	$ 36,000.00	$ 36,000.00	N
Westslope Chapter of Trout Unlimited	$ -	$ 5,000.00	$ 5,000.00	N
Clark Fork Coalition	$ -	$ 5,675.00	$ 5,675.00	Y
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
TOTALS	$ -	$ 120,675.00	$ 120,675.00	

OTHER CONTRIBUTIONS

(contributions not associated with the application)

CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
trees/rootwads (in-kind from landowner)	$ 6,000.00	$ -	$ 6,000.00	Y
Install Containerized Woody Plants (volunteers)	$ 500.00	$ -	$ 500.00	Y
Install Wire Cage (volunteers)	$ 400.00	$ -	$ 400.00	Y
Apply Seed (volunteers)	$ 75.00	$ -	$ 75.00	Y
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
TOTALS	$ 6,975.00	$ -	$ 6,975.00	


Miller Creek restoration Leik property
014-2024
N
GRAHAM
RODNEY E
LEIK THOMAS
H & DONNA A
WUSTNER
JACOB C
Bottom of Reach:
46.77754, -113.96181
Miller Creek
Top of Reach:
46.77649, -113.95646
LEIK THOMAS
H & DONNA A
WUSTNER
JACOB C
Clark Fork River
Missoula
MOUNT
JUMBO
S Reserve St
Brooks St
0
0.03
0.05
0.1 Miles
CLARK FORK
COALITION



RESTORATION GOALS

- INCREASE RIPARIAN WOODY VEGETATION COVER
- REDUCE FINE SEDIMENT INPUTS
- INCREASE AQUATIC HABITAT DIVERSITY
- INCREASE FLOODPLAIN CONNECTIVITY AND FUNCTION

DESIGN RESTORATION TREATMENTS

- CHANNEL REALIGNMENT
- HIGH FLOW CHANNEL CREATION
- INEZ CREEK REALIGNMENT
- ALCOVE
- FLOODPLAIN GRADING & ENHANCEMENT
- EXISTING CHANNEL FILL TO CREATE FLOODPLAIN
- HARDENED CROSSING
- FLOODPLAIN TREATMENT
- WOODY DEBRIS MATRIX
- SIDE CHANNEL WOODY DEBRIS MATRIX
- WILLOW BRUSH TRENCH
- FENCE
- EXISTING FENCE
- LARGE WOOD STRUCTURE
- STEP POOL STRUCTURE

geum Environmental Consulting
307 STATE ST
HAMILTON, MT 59840
406.363.2353
geumconsulting.com

DATUM: North American Datum 1983

PROJECTION: Montana State Plane

UNIT: INTL Foot

DATA SOURCES:
Geum UAS Imagery, 07/23
ESRI Basemap Imagery, 2018
Missoula County Cadastral, 2020

RESTORATION TREATMENT OVERVIEW

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum

DESIGNED BY: Geum

DATE: October 2023

SHEET
X.X

Leik Property – Miller Creek Restoration Project – Photos

October 22, 2021

To: Katie Racette, Project Manager

Clark Fork Coalition

PO Box 7593

Missoula, Montana 59807

From: Thomas and Donna Leik, Landowner

10832 Miller Creek Road

Missoula MT 59803

RE: Letter of Support for Leik- Miller Creek Sediment Reduction Project

We are landowners in the middle reach of Miller Creek, purchasing this 80 acre parcel in 1990. During the last 31 years we have observed changes and environmental events that impact the health of the creek. On the plus side we have added small pasture fencing to control grazing and have seen significant increases in the cottonwood and alders on the creek banks. On the negative side we have had several huge spring runoff events that have eroded the steam banks and flattened the channel by filling in the deep holes with cobble. In the last 20 years we have also experienced several very low water flow events both in the late summer and winter. We would like to support improvements to water quality, fisheries habitat, riparian conditions, and stream channel stability on this reach of Miller Creek. Conserving fish and wildlife habitat is important to us.

The Miller Creek Sediment Reduction Project, led by the Clark Fork Coalition (CFC), is proposed on a 1/4 mile reach of Miller Creek running through our property in order to reduce fine sediments, increase connectivity, enhance aquatic habitat, and to increase ecological function of the riparian and floodplain corridor. We support this project and will coordinate with CFC, DEQ, FWP, and contractors on granting permission for access to the site. Thank you.

Thomas Leik Date: 10/27/21

Thomas Leik

Donna Leik Date: 10/27/21

Donna Leik

Missoula City-County Health Department
WATER QUALITY DISTRICT
301 W Alder | Missoula MT 59802-4123
www.missoulacounty.us/wqd
Phone | 406.258.4890
Fax | 406.258.4781

October 26, 2021

319 Review Committee
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620

RE: Clark Fork Coalition 319 Grant Application

Dear 319 Review Committee,

The Missoula Valley Water Quality District would like to extend our support for the Clark Fork Coalition 319 application to reduce pollutant loading to Miller and O'Brien Creeks. This project aligns with the goals of the Missoula Valley Water Quality District to improve water quality across the district and within the watershed that supplies our sole source aquifer.

Thank you for the opportunity to demonstrate our support for this project.

Sincerely,

Elena Evans
Hydrogeologist
Missoula Valley Water Quality District

MILLER CREEK LEIK PARCEL RESTORATION PROJECT - 30% DESIGN

Missoula County, Montana

PREPARED FOR:

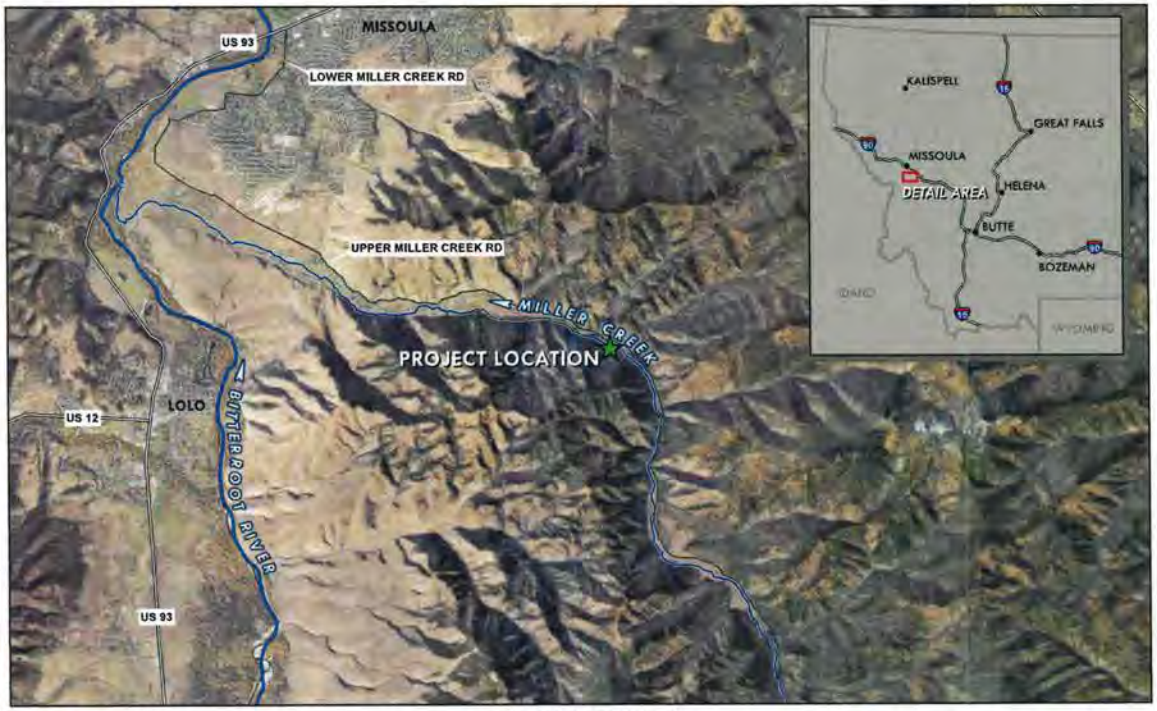
CLARK FORK COALITION

Clark Fork Coalition
140 South 4th West, Suite 1
Missoula, MT 59801
(406) 542-0539

PREPARED BY:

Geum Environmental Consulting

Geum Environmental Consulting, Inc.
307 State Street
Hamilton, Montana 59840
(406) 363-2353



SHEET INDEX

PROJECT DESCRIPTION

Miller Creek is listed for temperature and sediment impairments on the 2016 Clean Water Act 303(d) list. A water body is determined to be impaired if it does not meet all of its potential beneficial uses, such as recreation, fishery, agriculture, etc. Miller Creek is located in Missoula County, Montana. The Clark Fork Coalition, along with other partners are pursuing opportunities to reduce temperature and sediment impairments and improve aquatic habitat within the watershed. The project site is located on private land approximately 6.5 miles upstream from the confluence with the Bitterroot River.

DIRECTIONS TO SITE

From Missoula, Montana: Take Brooks Street/US Highway 93 South to the intersection with Lower Miller Creek Road. Turn east onto Lower Miller Creek Road and travel ~5.5 miles. Continue on Miller Creek Road/Upper Miller Creek Road, and travel 4.5 miles to the project site located on the right.

014-2024

Geum Environmental Consulting
307 STATE ST
HAMILTON, MT 59840
406-363-2353
geumconsulting.com

DATUM: North American Datum 1983
PROJECTION: Montana State Plane
UNIT: INTL Foot
DATA SOURCES:
USDA NAIP Imagery, 2017
ESRI Terrain Basemap
NHD Streams
MSL Roads, Towns, Borders

COVER SHEET

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
1.0

Miller Creek restoration Leik property

014-2024

geum Environmental Consulting
307 STATE ST
HAMILTON, MT 59840
406.531.8703
geumconsulting.com

DATUM: North American Datum 1983
PROJECTION: Montana State Plane
UNIT: INTL Foot
DATA SOURCES:
ESRI Basemap Imagery, 2018
Missoula County Cadastral, 2020

EXISTING CONDITION

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
2.0

Miller Creek is located in Missoula County, Montana. It flows west for 18 miles from the Sapphire Mountains to its confluence with the Bitterroot River near Missoula, Montana. The watershed is 47.9 square miles in size and supports a variety of land uses such as silviculture, agriculture, road construction, and residential subdivisions. These land uses have reduced riparian vegetation cover and straightened the channel which has led to channel incision and reduced floodplain connectivity, increased active erosion, reduced aquatic habitat diversity, increased stream temperatures, dewatering and reduced the number of beaver active in the watershed.

The project site includes 1,775 feet of Miller Creek. Elevation ranges from 3,759 feet at the upstream end to 3,738 feet at the downstream end. The project site is characterized by disturbed conditions from road construction, channel straightening, removal of riparian vegetation, and decreased beaver activity. Inez Creek enters Miller Creek in this reach. This reach is bounded by the road and terraced pasture in the upstream end and a steep hillside and developed pasture in the downstream end. Habitat is simplified due to the straightened planform and entrenchment, but some pools are present. There are several actively eroding streambanks contributing sediment to the channel. Woody riparian vegetation is present along some of the channel and in some depositional areas, but streambanks and the riparian area consist primarily of introduced pasture grasses.

UPPER MILLER CREEK STREAM CHARACTERISTICS

DRAINAGE AREA (*Upstream of site*)	34.2 sq. miles
MEAN ANNUAL PRECIPITATION	29 inches
FOREST COVER	80% Forested
BASEFLOW DISCHARGE	5-7 cfs
EST. BANKFULL DISCHARGE	70-80 cfs
EST. 10-YEAR DISCHARGE	185 cfs
EST. 100-YEAR DISCHARGE	630 cfs
VALLEY GRADIENT	0.016 ft/ft (1.6%)
CHANNEL GRADIENT	0.012 ft/ft (1.2%)
STREAMBED D50	1.8-inch gravel
STREAMBED D84	3-inch small cobble
EXISTING STREAM TYPE	G4 (upstream) and C4 (downstream)

Miller Creek restoration Leik property

014-2024

DESIGN RESTORATION TREATMENTS

- CHANNEL REALIGNMENT
- HIGH FLOW CHANNEL CREATION
- INEZ CREEK REALIGNMENT
- ALCOVE
- FLOODPLAIN GRADING & ENHANCEMENT
- EXISTING CHANNEL FILL TO CREATE FLOODPLAIN
- HARDENED CROSSING
- FLOODPLAIN TREATMENT
- WOODY DEBRIS MATRIX
- SIDE CHANNEL WOODY DEBRIS MATRIX
- WILLOW BRUSH TRENCH
- FENCE
- LARGE WOOD STRUCTURE
- STEP POOL STRUCTURE

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406.375.0553
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DATUM: North American Datum 1983
PROJECTION: Montana State Plane
UNIT: INTL Foot
DATA SOURCES:
Geum UAS Imagery, 07/23
ESRI Basemap Imagery, 2018
Missoula County Cadastral, 2020

RESTORATION TREATMENT OVERVIEW

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
3.0

Miller Creek restoration Leik property

014-2024

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307 STATE ST
HAMILTON, MT 59840
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geumconsulting.com

DATUM: North American Datum 1983

PROJECTION: Montana State Plane

UNIT: INTL Foot

DATA SOURCES:
Geum UAS Imagery, 07/23
ESRI Basemap Imagery, 2018
Missoula County Cadastral, 2020

SITE PLAN

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum

DESIGNED BY: Geum

DATE: October 2023

SHEET
4.0

GENERAL SPECIFICATIONS

1. The project will be constructed according to the plan set. The contractor will notify the project manager of any changes prior to implementation.

2. It is the contractors' responsibility to identify all underground utilities prior to construction.

3. Elevations in the plan set are based on survey work performed by Geum and Coldwater in 2023. Survey control points have been established for the work. Earthwork quantities reported on the drawings are approximate. The project manager will provide staking and layout to guide work.

4. All existing conditions are to be verified in the field prior to construction and any adjustments to the drawings will be made as directed by the project manager.

5. Drawings are not intended to provide means or methods of construction.

6. Excavation will meet the requirements of OSHA 29 CFR Part 1926, Subpart P, Excavations.

7. Copies of all project permits will be provided to the contractor. The contractor will comply with the provisions of the permits. The contractor will notify the project manager of any known changes or activities that could violate permit requirements prior to implementation. The project manager will be responsible for all correspondence with permitting agencies.

DEWATERING PLAN and EROSION CONTROLS

1. Work will occur during seasonal low flows between August and October. Mean daily flow conditions during construction are expected to be between 5 and 10 cfs.

2. The following is the anticipated erosion control and water management strategy for the work:

   a. Streambanks:

      i. Install sediment control measures at the downstream of each work site.

      ii. Minimize disturbance of the channel bed at each site.

   b. Channel Realignments:

      i. Complete segments of channel that can be constructed in the dry first.

      ii. Where the new channel intersects the existing channel, working in flowing conditions will be required. Where feasible, coffer dams should be constructed to isolate channel excavation areas.

      iii. Install temporary erosion control measures at the downstream end of each channel realignment segment.

      iv. Observe all abandoned channel segments for stranded fish and relocate fish to flowing channels.

3. Contractor may propose an alternate dewatering plan and must submit the plan in writing prior to start of work.

4. Efforts should be made to limit turbidity during in water work.

5. Efforts should be made to limit disturbance to vegetation.

6. Efforts should be made to avoid fatalities of aquatic life.

CONSTRUCTION SPECIFICATIONS

1. Construction will occur as specified in the plan set, general specifications, materials specifications, dewatering and erosion control procedures, and construction specifications.

2. Access routes will be determined by the project manager and landowner. Construction equipment will not cross private land unless permission is obtained from the landowner. The contractor will leave all gates, whether open or closed, as found.

3. Stream crossings will occur in designated locations only.

4. Disturbance to riparian vegetation, wetland areas, channel banks, and existing infrastructure outside of work limits will be minimized. Any desirable vegetation within construction limits will be salvaged and transplanted into streambank treatments or floodplains as directed by the project manager.

5. Storm water will be routed away from active construction areas as needed into natural depressions in existing topography or constructed ditches as required. Practices will be monitored for effectiveness to determine if additional control measures are warranted. Additional control measures may include use of straw bales (certified weed-free only), coir wattles, or other BMPs effective at minimizing surface erosion and delivery of sediment to water bodies. Where wetlands are adjacent to the project boundary, silt fence may be required so there is no direct sediment delivery to the wetland. Temporary erosion controls will be in place before any significant alteration of the site occurs

6. The contractor will furnish all equipment necessary to construct the project. The contractor will mobilize all equipment to the project area as directed by the project manager. All vehicle staging, fueling, storage, and washout areas will be located at least 150 feet away from aquatic areas and adequately buffered such that runoff is incapable of being delivered to surface water or wetlands.

7. All equipment will be washed prior to mobilization to the site to minimize the introduction of foreign materials and fluids to the project site. All equipment will be free of oil, hydraulic fluid, and diesel fuel leaks. To prevent invasion of noxious weeds or the spread of aquatic invasive species, all equipment will be power washed or cleaned to remove mud and soil prior to mobilization into the project area. It will be the contractor's responsibility to ensure that adequate measures have been taken.

8. Equipment will be in a well-maintained condition to minimize the likelihood of a fluid leak. If a fluid leak does occur, the project manager will be notified immediately, and all work ceased until the leak has been rectified. All power equipment will be cleaned and leaks repaired at least 150 feet from any natural waterbody or wetland. At all times during construction, fluid spill containment equipment (e.g. oil-absorbing floating boom and absorbent pads) will be present on-site and ready for deployment should an accidental spill occur. The contractor will remove soil from the project site if the soil is tainted with petroleum-based fluids.

MATERIALS SPECIFICATIONS

1. The contractor will furnish all materials necessary to construct the project unless otherwise specified in the plan set. The contractor will deliver all materials to designated stockpile or staging locations labeled on the plan set or otherwise determined by the project manager.

2. Material quantities, dimensions and sizes will conform to the notes and specifications provided on the plan set or on the materials list. Whole trees with rootwads intact will be harvested on site. Contractor is responsible for cutting trees to dimensions required to complete work.

3. The project manager will inspect and approve all materials prior to construction. If materials do not meet the minimum requirements specified in the plan set or material list, the project manager reserves the right to reject the materials.

4. Excess material will be hauled to the general location shown on Sheet 4.0. Top soil will be stockpiled separately from gravel and alluvium. Material will be spread into the existing ditch as directed by the project manager.

5. Overexcavation may be required if unsuitable soils (i.e. excessive organic matter, sand, etc.) are encountered in channel realignment or streambank treatment locations.

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CONSTRUCTION NOTES and SPECIFICATIONS

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

Miller Creek restoration Leik property

014-2024

CHANNEL PROFILE

geum Environmental Consulting
307 STATE ST
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geumconsulting.com

DATUM: North American Datum 1983
PROJECTION: Montana State Plane
UNIT: INTL Foot
DATA SOURCES:
Geum UAS Imagery, 07/23

CHANNEL PLAN VIEW and PROFILE

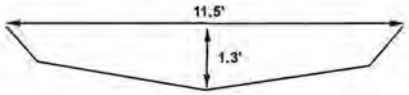
MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

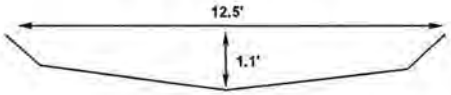
SHEET
6.0

CHANNEL DESIGN TEMPLATES

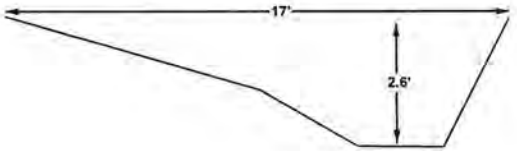
TYPICAL RUN CROSS SECTION



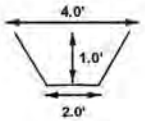
TYPICAL RIFFLE CROSS SECTION



TYPICAL POOL CROSS SECTION



TYPICAL SIDE CHANNEL CROSS SECTION



CHANNEL REALIGNMENT PROFILES
AND CHANNEL FEATURE SCHEDULE
TO BE ADDED FOR FINAL DESIGN

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CHANNEL TEMPLATES

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
6.1

MAIN CHANNEL STRUCTURE SCHEDULE

STATION START	STATION END	BANK	TOB ELEVATION START	TOB ELEVATION END	STRUCTURE
1+90	3+40	L	3758.8	3756.8	WDM1
2+50		L			LWS
3+00		L			LWS
3+40	4+20	L	3756.8	3755.9	WBT1
3+50	4+10	R	3756.9	3756.0	WDM1.5
3+65		R			LWS
4+20	4+85	L	3755.9	3754.5	WDM2
4+75		L			LWS
5+25		ACROSS			STEP POOL
5+75		ACROSS			STEP POOL
6+25		ACROSS			STEP POOL
6+35	6+60	L	3752.3	3752.1	WBT2
6+40	6+65	R	3752.3	3752.1	WDM3
6+50		R			LWS
6+60	7+20	L	3752.1	3751.7	WDM4
6+65	7+15	R	3752.1	3751.9	WBT3
6+80		L			LWS
7+15	7+70	R	3751.9	3750.8	WDM5
7+20	7+65	L	3751.7	3750.9	WBT4
7+50		R			LWS
7+65	8+35	L	3750.9	3750.2	WDM6
7+70	8+15	R	3750.8	3750.6	WBT5
8+00		L			LWS
8+40	9+00	L	3750.2	3749.1	WDM7
8+80		L			LWS
9+10	9+70	R	3749.1	3748.2	WDM8
11+10	12+00	L	3747.0	3746.4	WBT6
11+10	11+95	R	3747.0	3746.4	WDM9
11+65		R			LWS
12+05	13+55	L	3746.4	3744.0	WDM10
13+10					LWS
13+35					LWS
14+60	14+80	L	3743.2	3743.2	WBT7
14+60	14+90	R	3743.2	3743.0	WDM11
14+70		R			LWS
14+80	15+35	L	3743.2	3742.5	WDM12
15+25		L			LWS
14+90	15+30	R	3743.0	3742.6	WBT8
15+30	15+45	R	3742.6	3742.5	WDM13
15+35	15+70	L	3742.5	3742.4	WBT9
15+50	15+70	R	3742.5	3742.4	WDM14

SIDE CHANNEL STRUCTURE SCHEDULE

STATION START	STATION END	BANK	TOB ELEVATION START	TOB ELEVATION END	STRUCTURE
0+00	0+90	R	3758.8	3758.9	SCWDM1
0+00	0+90	L	3758.8	3757.0	SCWDM2
0+30		ACROSS			WBT
0+45		ACROSS			WBT
0+60		ACROSS			WBT
0+85		ACROSS			WBT
0+00	0+60	L	3750.5	3749.1	SCWDM3
0+00	0+65	R	3750.6	3749.1	SCWDM4
0+10		ACROSS			WBT
0+20		ACROSS			WBT
0+30		ACROSS			WBT
0+45		ACROSS			WBT
0+60		ACROSS			WBT
0+00	0+65	L	3749.1	3748.1	SCWDM5
0+00	0+60	R	3748.9	3748.1	SCWDM6
0+05		ACROSS			WBT
0+15		ACROSS			WBT
0+25		ACROSS			WBT
0+35		ACROSS			WBT
0+45		ACROSS			WBT
0+00	0+60	L	3743.1	3742.5	SCWDM7
0+00	0+60	R	3743.0	3742.5	SCWDM8
0+10		ACROSS			WBT
0+25		ACROSS			WBT
0+40		ACROSS			WBT
0+55		ACROSS			WBT

STRUCTURE TYPE LEGEND

WDM: WOODY DEBRIS MATRIX STREAMBANK TREATMENT

LWS: LARGE WOODY DEBRIS STRUCTURE

WBT: WILLOW BRUSH TRENCH

SCWDM: SIDE CHANNEL WOODY DEBRIS MATRIX STREAMBANK TREATMENT

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STRUCTURE SCHEDULE

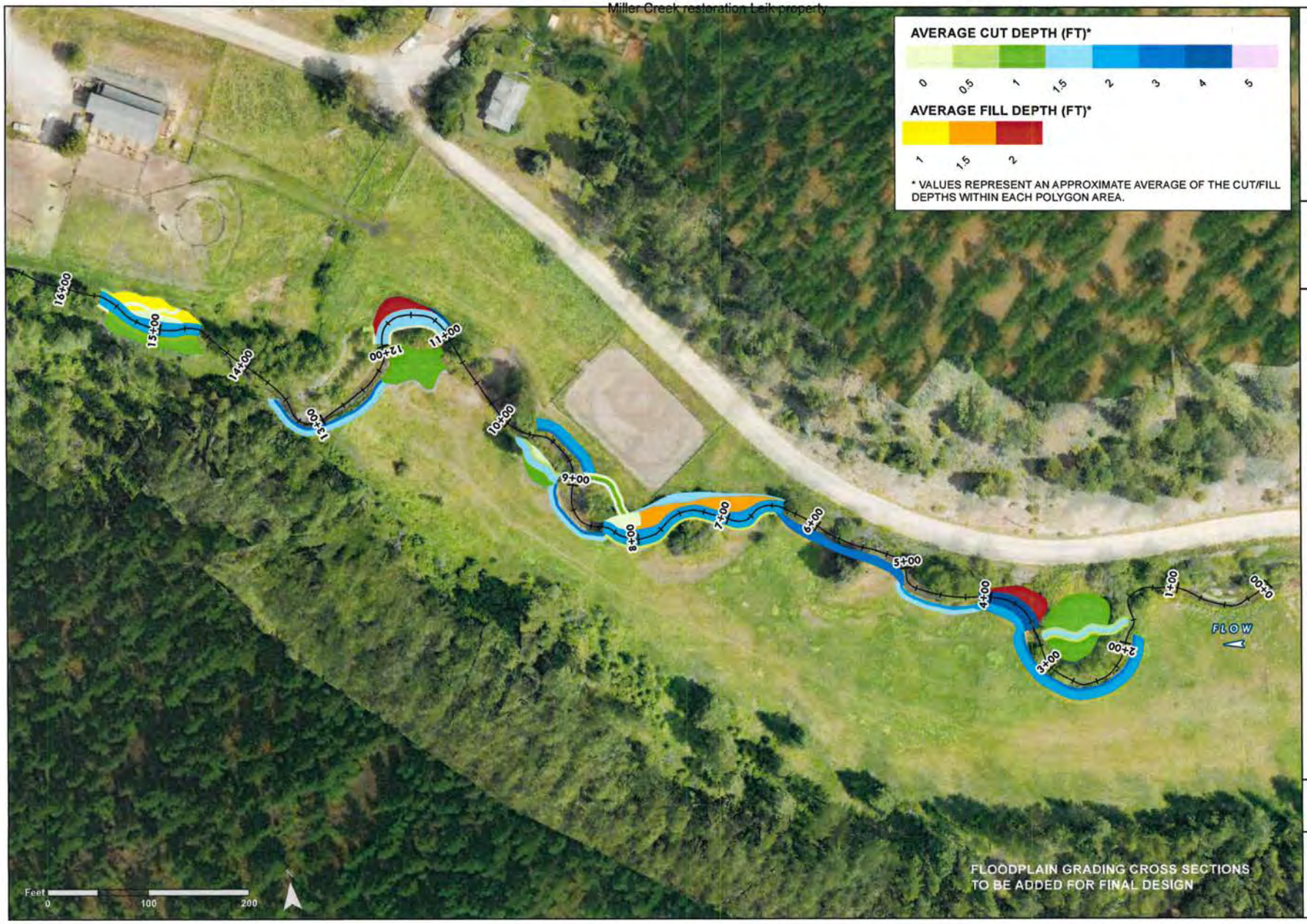
MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
6.2

Miller Creek restoration Leik property

014-2024



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307 STATE ST
HAMILTON, MT 59840
406.381.3253
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DATUM: North American Datum 1983

PROJECTION: Montana State Plane

UNIT: INTL Foot

DATA SOURCES:
Geum UAS Imagery, 07/23
ESRI Basemap Imagery, 2018
Missoula County Cadastral, 2020

FLOODPLAIN GRADING PLAN

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum

DESIGNED BY: Geum

DATE: October 2023

SHEET
7.0

TREATMENT TYPE	UNITS	ESTIMATED QUANTITY
CHANNEL REALIGNMENT	LINEAR FEET	463
WOODY DEBRIS MATRIX STREAMBANK TREATMENT	LINEAR FEET	1,076
LARGE WOODY DEBRIS STRUCTURE	EACH	14
FLOODPLAIN ROUGHNESS	ACRES	0.3
SIDE CHANNEL	LINEAR FEET	304
SIDE CHANNEL BRUSH MATRIX STREAMBANK TREATMENT	LINEAR FEET	553
WILLOW BRUSH TRENCH	LINEAR FEET	825
STEP POOL STRUCTURE	EACH	3
LIVESTOCK FENCE	LINEAR FEET	1,958

EXCAVATION	UNITS	ESTIMATED QUANTITY
ESTIMATED EXCAVATION	CUBIC YARD	1,810
ESTIMATED FILL	CUBIC YARD	250
ESTIMATED VOLUME OF EXCAVATED MATERIAL TO BE HAULED TO EXCESS MATERIAL DISPOSAL SITE	CUBIC YARD	1,560

MATERIALS	UNITS	ESTIMATED QUANTITY
WOOD*		
LOGS w/ ROOTWADS (12" D x 10-15' L)	EACH	56
LOGS w/out ROOTWADS (6-12" D x 10-15' L)	EACH	70
LARGE LOG W/ ROOTWAD (12" D x 25' L)	EACH	3
MEDIUM LOG W/ OPTIONAL ROOTWAD (12" D x 20' L)	EACH	3
BACKER LOG W/out ROOTWAD (12" D x 20' L)	EACH	3
BRUSH and SMALL WOOD (3-8" x 8-10' L)	EACH	3,714
ROCK		
24-36" BOULDERS/FOOTER ROCKS	EACH	115
12" LARGE ROCK	EACH	15
4-6" TOE COBBLE	CUBIC YARDS	323
REVEGETATION		
WILLOW CUTTINGS	EACH	13,674

*TO BE HARVESTED ONSITE

HARDENED CHANNEL CROSSING MATERIALS	UNITS	ESTIMATED QUANTITY
6"+ COBBLE	CUBIC YARD	3
4" CRUSHED ROCK	CUBIC YARD	5

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DATUM:
PROJECTION:
UNITS: INTL Feet
DATA SOURCES:

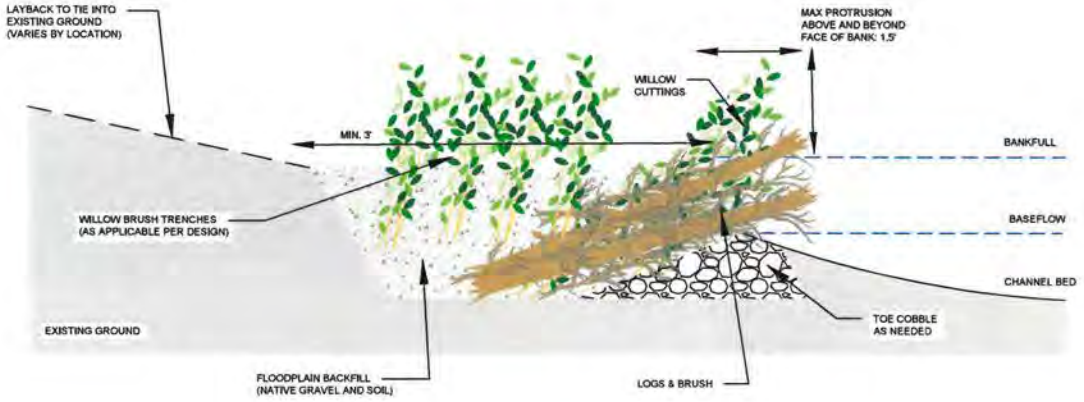
PROJECT MATERIALS AND QUANTITIES

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
8.0

WOODY DEBRIS MATRIX
SECTION VIEW



GENERAL NOTES

THIS WORK INCLUDES INSTALLATION OF WOODY DEBRIS MATRIX STREAMBANK TREATMENTS AT THE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THESE STRUCTURES IS TO PROVIDE TEMPORARY BANK STABILIZATION AND CREATE A COMPLEX, VEGETATED BANK MARGIN THAT CREATES AQUATIC HABITAT AND SUPPORTS VEGETATION ESTABLISHMENT.

NOTES ON WOODY DEBRIS MATRIX STREAMBANK INSTALLATION

1. EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
2. CONSTRUCT STREAMBANK TOE WHERE NEEDED AND ACCORDING TO SPECIFIED DIMENSIONS.
3. INSTALL MATRIX OF LOGS AND BRUSH. LOGS CAN OVERLAP AND CAN BE ORIENTED FACING UPSTREAM OR DOWNSTREAM, BUT SHOULD BE PLACED BELOW THE BANKFULL ELEVATION.
4. PLACE WILLOW CUTTINGS INTO THE MATRIX AS SHOWN IN THE DRAWING WITH THE STEMS IN CONTACT WITH THE BASEFLOW WATER TABLE AND TOPS AT OR ABOVE THE BANKFULL ELEVATION.
5. BACKFILL STREAMBANK WITH FLOODPLAIN BACKFILL TO DESIGN ELEVATIONS. WASH FINES INTO THE FLOODPLAIN BACKFILL TO SEAL VOIDS.
6. LAY BACK THE GROUND BY EXCAVATING MATERIAL TO FORM A SLOPE AT A MINIMUM OF 3H:1V TO BLEND WOODY DEBRIS MATRIX STREAMBANK TO ADJACENT EXISTING GROUND.
7. ROUGHEN FLOODPLAIN BENCH AND SLOPE AND INSTALL TREES AND SHRUBS.

EXAMPLES OF WOODY DEBRIS MATRIX STREAMBANK TREATMENTS

MAIN CHANNEL - MATERIAL SCHEDULE		
ITEM	DIMENSIONS	QUANTITY/LINEAR FOOT
BRUSH AND SMALL WOOD	3-8" D, 8-10' L	2
WILLOW CUTTINGS	MIN. ¾" D, 8' L	5
TOE COBBLE MIX*	4" MINUS	0.3 CY
FLOODPLAIN BACKFILL	NATIVE	1 CY

*WILL ONLY BE IMPORTED AS NEEDED

SIDE CHANNEL - MATERIAL SCHEDULE		
ITEM	DIMENSIONS	QUANTITY/LINEAR FOOT
BRUSH AND SMALL WOOD	3-8" D, 8-10' L	1
WILLOW CUTTINGS	MIN. ¾" D, 8' L	5
FLOODPLAIN BACKFILL	NATIVE	1 CY

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DATUM:
PROJECTION:
UNITS: INTL Feet
DATA SOURCES:

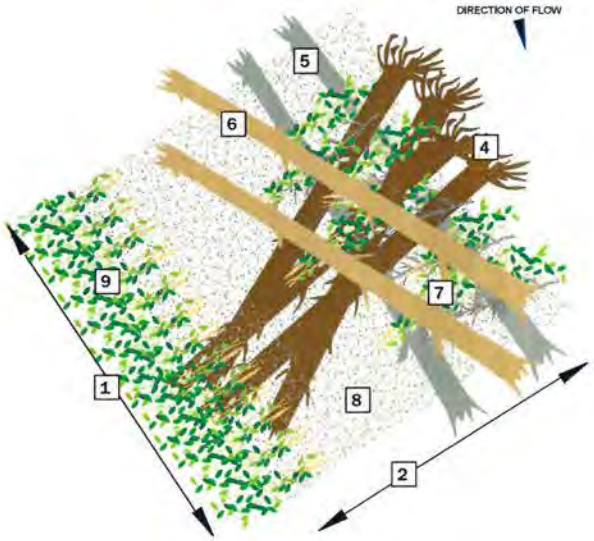
WOODY DEBRIS MATRIX STREAMBANK TREATMENT

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

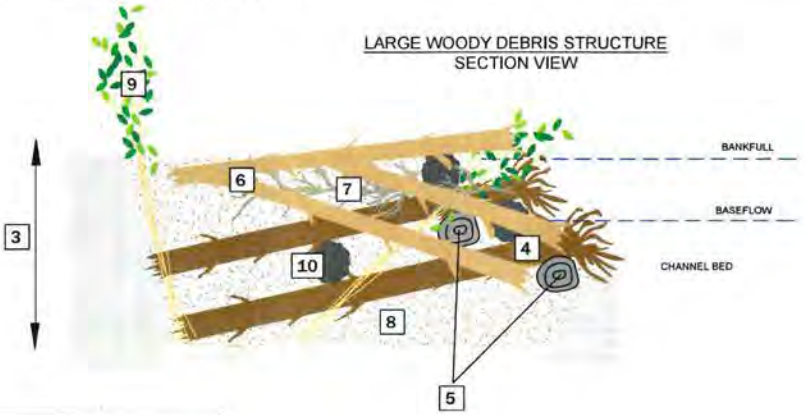
DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
D1

LARGE WOODY DEBRIS STRUCTURE
PLAN VIEW



LARGE WOODY DEBRIS STRUCTURE
SECTION VIEW



DIMENSIONS AND MATERIALS	
1	AVERAGE STRUCTURE LENGTH: 10-15'
2	AVERAGE STRUCTURE WIDTH: 8'
3	MAXIMUM SCOUR DEPTH: 3'
4	ROOTWAD LOG
5	FOOTER LOG
6	DEFLECTOR LOG
7	BRUSH AND SMALL WOOD
8	STREAMBANK FILL
9	WILLOW CUTTINGS
10	BOULDERS

MATERIAL SCHEDULE

ITEM	DIMENSIONS	QUANTITY/STRUCTURE
ROOTWAD LOG	3' MIN. ROOTWAD D, 12" MIN. D, 15' L	4
FOOTER LOG	8-12" D, 15' L	2
DEFLECTOR LOG	6-10" D, 10-15' L	2
BRUSH AND SMALL WOOD	3-8" D, 8-12' L	8
WILLOW CUTTINGS	05-1" D, 6-8' L	100
STREAMBANK FILL	NATIVE	5 CY
SUBGRADE EXCAVATION		10 CY
BOULDER	24-36"	5

GENERAL NOTES

THIS WORK INCLUDES INSTALLATION OF LARGE WOODY DEBRIS STRUCTURES AT THE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THIS STRUCTURE IS TO PROVIDE TEMPORARY BANK STABILIZATION BY DIRECTING THE FLOW AWAY FROM THE STREAMBANK AND TO CREATE HYDRAULIC CONDITIONS THAT MAINTAIN A POOL. THIS STRUCTURE ALSO PROVIDES A LOW STRESS AREA FOR BANK VEGETATION TO ESTABLISH. THE STRUCTURE PROVIDES MULTIPLE LAYERS OF WOOD AND BRUSH TO INCREASE CHANNEL ROUGHNESS ALONG THE BANK AND INCREASE AQUATIC HABITAT DIVERSITY. THIS STRUCTURE IS USED IN CONJUNCTION WITH OTHER STRUCTURES SUCH AS THE WOODY DEBRIS MATRIX, AND SMOOTH TRANSITIONS BETWEEN STRUCTURE TYPES IS KEY TO OVERALL FUNCTION AND STABILITY.

NOTES ON LARGE WOODY DEBRIS STRUCTURE INSTALLATION

1. EXCAVATE TO SUBGRADE ELEVATIONS AND STOCKPILE SUITABLE EXCAVATED MATERIAL FOR BACKFILL.
2. INSTALL THE TIER OF FOOTER LOGS (TIER 1) AND TIER OF ROOTWAD LOGS (TIER 2) AS SPECIFIED. THE UPSTREAM ROOTWAD SHOULD NOT PROJECT INTO THE CHANNEL, AND SHOULD BE FLUSH WITH THE BANKLINE. THE DOWNSTREAM-MOST ROOTWAD SHOULD PROJECT 2' TO 3' INTO THE CHANNEL.
3. BACKFILL WITH STREAMBANK FILL UP TO THE TOP OF THE ROOTWAD LOGS AND COMPACT VIA BUCKET COMPACTION. WASH FINES AND WATER FROM ON-SITE INTO THE STREAMBANK FILL TO SEAL VOIDS IN THE BACKFILL.
4. INSTALL THE TIER OF DEFLECTOR LOGS, BRUSH, AND SMALL WOOD (TIER 3) WITHIN THE MATRIX OF FOOTER LOGS AND ROOTWAD LOGS. LOGS SHALL BE WOVEN BETWEEN OTHER LOGS TO PREVENT MOVEMENT. DEFLECTOR LOGS SHALL POINT DOWNSTREAM AND MAY EXTEND UP TO ONE FOOT ABOVE THE TOP OF BANK ELEVATION.
5. INSTALL DORMANT WILLOW CUTTINGS IN MATRIX OF LOGS AND BRUSH ALONG THE BANKLINE OR BACK EDGE OF EXCAVATION.
6. BACKFILL STREAMBANK WITH STREAMBANK FILL AND WASH FINES FROM ON-SITE INTO THE STREAMBANK FILL TO SEAL VOIDS.

EXAMPLES OF LARGE WOODY DEBRIS STRUCTURE TREATMENTS

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DATUM:
PROJECTION:
UNITS: US Feet
DATA SOURCES:

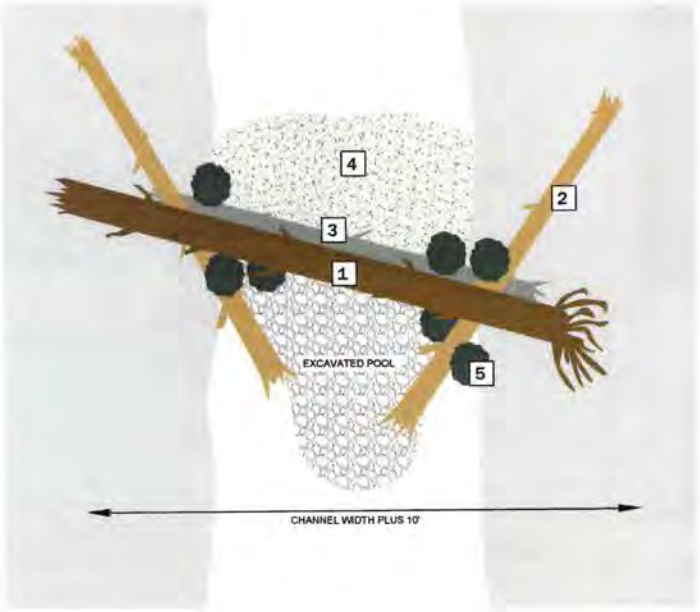
LARGE WOODY DEBRIS STRUCTURE DETAIL

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

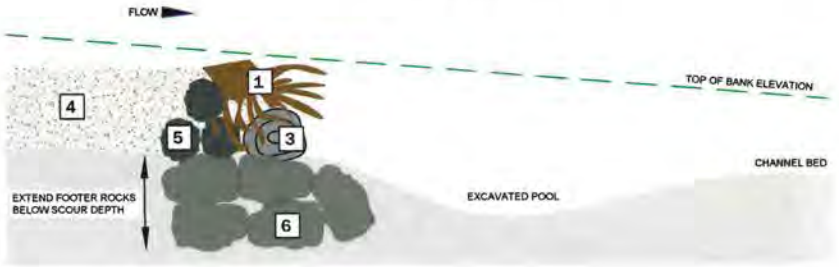
DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

SHEET
D2

STEP POOL STRUCTURE
PLAN VIEW



STEP POOL STRUCTURE
PROFILE VIEW



MATERIAL TYPES	
1	LARGE LOG
2	MEDIUM LOG
3	BACKER LOG
4	STREAMBED FILL (EXCAVATED FROM POOL)
5	LARGE ROCK
6	FOOTER ROCK

MATERIAL SCHEDULE

ITEM	DIMENSIONS	QUANTITY/STRUCTURE
LARGE LOG	3' MIN. ROOTWAD D, 12" MIN. D, 25' L	1
MEDIUM LOG	ROOTWAD OPTIONAL, 12" MIN. D, 20' L	1
BACKER LOG	12-15" D, 20' L	1
STREAMBED FILL	NATIVE	2 CY
LARGE ROCK	12"	5
FOOTER ROCK	24-36"	15

GENERAL NOTES

THIS WORK INCLUDES INSTALLATION OF STEP POOL STRUCTURES AT LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THIS STRUCTURE IS TO CREATE ADDITIONAL POOL HABITAT WITHIN STREAM REACHES WHERE CHANNEL MORPHOLOGY HAS BEEN SIMPLIFIED, AND TO PROVIDE STABILITY WITHIN THE REACH. THE STRUCTURES ARE DESIGNED TO MIMIC NATURALLY OCCURRING STEP POOL DOMINATED CHANNELS AND BEDFORMS. THE STRUCTURE IS COMPOSED OF LARGE LOGS AND NATIVE STREAMBED SUBSTRATE.

NOTES ON STEP POOL STRUCTURE INSTALLATION

1. EXCAVATE CHANNEL BED AND STREAMBANKS TO ACCOMMODATE LOG PLACEMENT. STREAMBED DOWNSTREAM OF LOGS SHALL BE EXCAVATED TO A DEPTH EQUAL TO THE AVERAGE POOL DEPTH AS INDICATED ON SHEET 6.1.
2. INSTALL FOOTER ROCK, FOOTER LOG, LARGE LOG AND MEDIUM LOGS AS INDICATED ON DRAWINGS AND DESCRIBED BELOW.
3. INSTALL FOOTER ROCKS IN STREAMBED TO A DEPTH BELOW THE SCOUR DEPTH. FOOTER ROCKS SHALL BE PLACED SUCH THAT THEY PREVENT SLUMPING OF THE STRUCTURE AND PREVENT SCOUR.
4. INSTALL LARGE LOG AT A DOWNWARD ANGLE AND AT AN ELEVATION 0.5 FOOT BELOW THE BANKFLL ELEVATION, EMBEDDED INTO THE STREAMBANK AND CHANNEL BED A MINIMUM OF ONE FOOT BELOW THE CHANNEL FINISH GRADE.
5. INSTALL MEDIUM LOGS AT THE CHANNEL TIE-IN POINTS FOR THE LARGE LOG AND THE BACKER LOG. ANGLE LOGS DOWNSTREAM AND INTO THE CHANNEL TOWARDS EXCAVATED POOL.
6. INSTALL BACKER LOG ON THE UPSTREAM SIDE OF LARGE LOG. BACKER LOG SHALL BE FLUSH WITH THE LARGE LOG AND EXTEND FROM THE FLOODPLAIN TIE-IN LOCATIONS TO THE TIP OF THE BURIED LARGE LOG.
7. INSTALL LARGE ROCK UPSTREAM AND DOWNSTREAM OF THE STREAMBANK TIE-IN LOCATIONS AND LARGE LOG TIPS. ROCK SHALL BE IN CONTACT WITH LOGS TO PROVIDE BALLAST AND PREVENT LOGS FROM SHIFTING WHEN BACKFILLED.
8. BACKFILL LOGS WITH STREAMBED FILL TO CHANNEL FINISH GRADE.

EXAMPLES OF STEP POOL STRUCTURE TREATMENTS

Geum Environmental Consulting
307 STATE ST.
HAMILTON, MT 59840
406.363.2353
geumconsulting.com

DATUM:
PROJECTION:
UNITS: INTL Feet
DATA SOURCES:

STEP POOL STRUCTURE DETAIL

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

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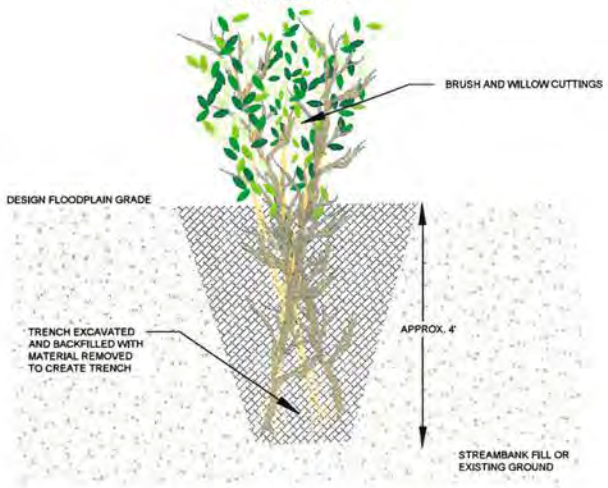
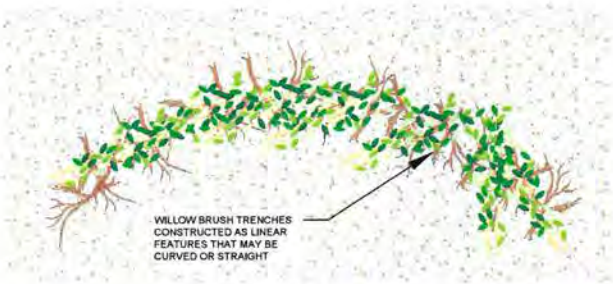
D3

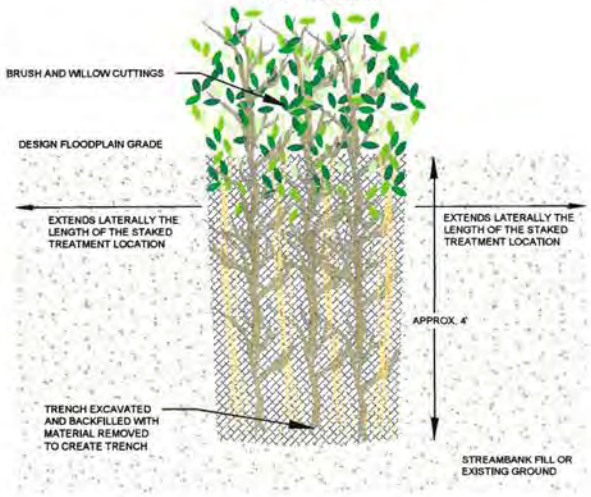
WILLOW BRUSH TRENCH
PROFILE VIEW



WILLOW BRUSH TRENCH
PLAN VIEW



WILLOW BRUSH TRENCH
SECTION VIEW



GENERAL NOTES

THIS WORK INCLUDES INSTALLATION OF WILLOW BRUSH TRENCHES IN APPROXIMATE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THESE FEATURES IS TO DISPERSE SURFACE FLOWS AND PROMOTE REVEGETATION. CONSTRUCTION OF WILLOW BRUSH TRENCHES WILL OCCUR IN CLOSE COORDINATION WITH INSTALLATION OF FLOODPLAIN ROUGHNESS AND CONSTRUCTION OF FLOODPLAIN SIDE CHANNELS. THE CONTRACTOR SHALL PROVIDE BRUSH AND WILLOW CUTTINGS.

NOTES ON WILLOW AND BRUSH TRENCH INSTALLATION

1. WILLOW BRUSH TRENCHES WILL BE CONSTRUCTED WITHIN THE FLOODPLAIN AND ACROSS SIDE CHANNELS IN APPROXIMATE LOCATIONS SHOWN ON SHEET 3.0. FINAL LOCATIONS WILL BE IDENTIFIED BY THE PROJECT MANAGER.
2. A TRENCH WILL BE CONSTRUCTED APPROXIMATELY 4' DEEP AND EXTEND THE LENGTH OF THE STAKED TREATMENT LOCATION. WILLOW CUTTINGS AND BRUSH WILL BE PLACED IN THE TRENCH SUCH THAT THEY ARE INTERMIXED AND ORIENTED AT A NEAR VERTICAL ANGLE.
3. THE TRENCH WILL THEN BE BACKFILLED WITH THE SAME MATERIAL REMOVED TO CREATE THE TRENCH AND SHOULD MATCH THE ELEVATION OF THE SURROUNDING FLOODPLAIN GRADE.

MATERIAL SCHEDULE

ITEM	DIMENSIONS	QUANTITY/LINEAR FOOT
BRUSH AND SMALL WOOD	<6" D, 6-10' L (BRANCHES AND MULTIPLE STEMS PREFERRED)	1
WILLOW CUTTINGS	MIN. ½" D, 8' L	5

EXAMPLES OF WILLOW BRUSH TRENCH TREATMENTS

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307 STATE ST.
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geumconsulting.com

DATUM:
PROJECTION:
UNITS: INTL Feet
DATA SOURCES:

WILLOW BRUSH TRENCH DETAIL

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

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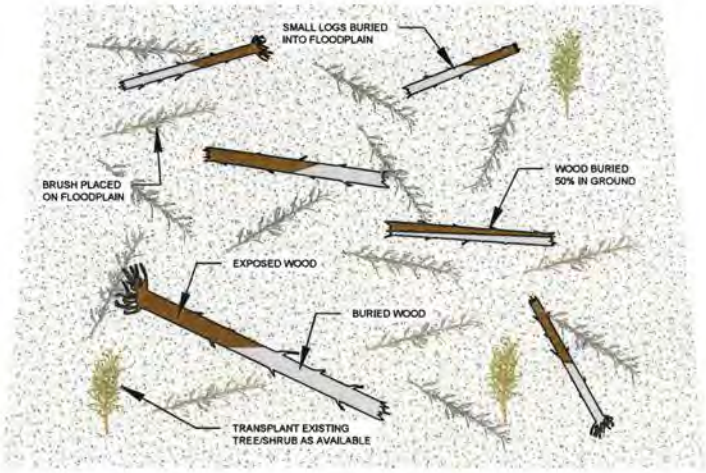
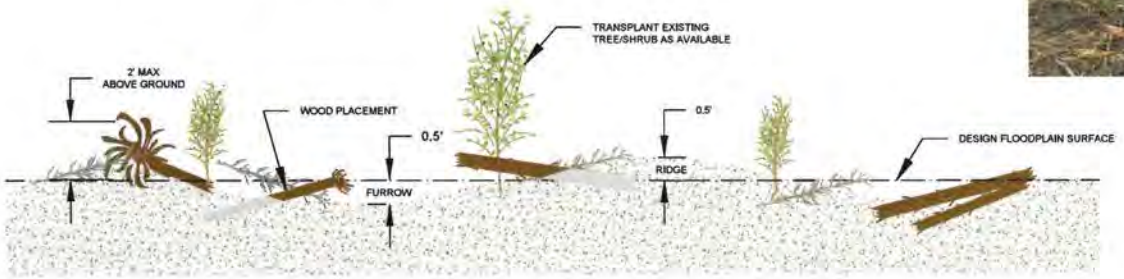
D4

FLOODPLAIN TREATMENT
PLAN VIEW



FLOODPLAIN TREATMENT
SECTION VIEW



GENERAL NOTES

THIS WORK INCLUDES CONSTRUCTION OF FLOODPLAIN TREATMENT AREAS. THE INTENT OF THIS TREATMENT IS TO PROVIDE MICROSITES AND ROUGHNESS TO SUPPORT SEED TRAPPING, ESTABLISHMENT OF VEGETATION AND DISPERSE OVERLAND FLOWS. WORK WILL OCCUR AFTER OR CONCURRENT WITH CONSTRUCTION OF THE FLOODPLAIN SIDE CHANNELS, WILLOW BRUSH TRENCHES AND STREAMBANK STRUCTURES.

NOTES ON FLOODPLAIN TREATMENT CONSTRUCTION

1. LOAD AND HAUL WOOD FROM THE STAGING AREAS TO THE TREATMENT LOCATIONS. HAUL AND STAGE THE WOOD AT THE INSTALLATION LOCATIONS IN A MANNER THAT PRESERVES THE SIZE, TYPE, AND INTEGRITY OF EACH PIECE TO BE INCORPORATED INTO THE WORK. HANDLE MATERIALS IN A MANNER THAT MINIMIZES DAMAGE TO BARK, LIMBS, AND ROOTWADS IF PRESENT (NO ROLLING, CRUNCHING, CRUSHING, ETC.)
2. PLACE SMALL LOGS AT A RATE OF 50 PIECES PER ACRE AND SPACED AT AN AVERAGE DISTANCE OF 15 FEET FROM OTHER LOGS. PLACE BRUSH SUCH THAT IS COVERS 25% OF THE FLOODPLAIN SURFACE (APPROXIMATELY 250 PIECES PER ACRE).
3. BURY SMALL LOGS WITHIN THE FLOODPLAIN SURFACE, WITH ONE HALF OF THE LENGTH BURIED TO A DEPTH OF 2 FEET AND ONE HALF EXPOSED A MAXIMUM OF 1 FOOT ABOVE FINISHED GRADE AS SHOWN ON DRAWING. PLACE BRUSH ON THE SURFACE, BRUSH DOES NOT NEED TO BE BURIED.
4. CONSTRUCT MICRO-TOPOGRAPHY CONSISTING OF LOW AND HIGH FEATURES (RIDGES AND FURROWS), WITH NO DISCERNABLE PATTERN (I.E NO ROWS), OVER THE ENTIRE LOWERED FLOODPLAIN AREA.

MATERIAL SCHEDULE

ITEM	DIMENSION	QUANTITY/ACRE
LOGS	6-12" D, 10-15' L	50 PIECES
BRUSH	<6" D, 6-10' L (BRANCHES AND MULTIPLE STEMS PREFERRED	APPROX. 250 PIECES (COVERING 25% OF THE AREA)

EXAMPLE OF FLOODPLAIN TREATMENT

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geumconsulting.com

DATUM:
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FLOODPLAIN TREATMENT DETAIL

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

DRAWN BY: Geum
DESIGNED BY: Geum
DATE: October 2023

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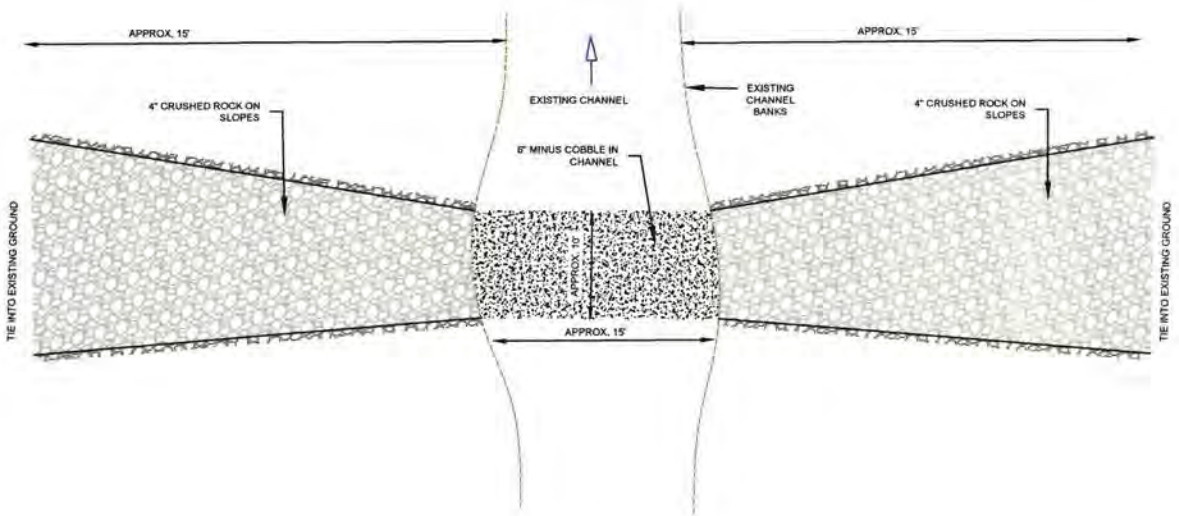
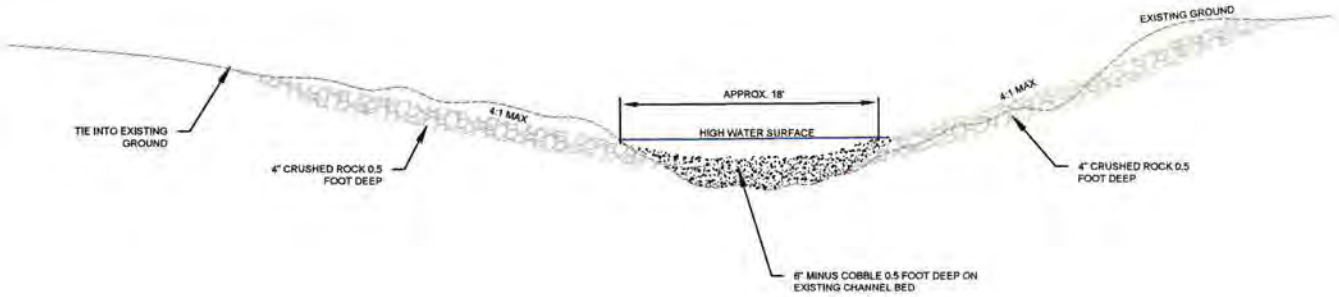
HARDENED CROSSING DETAIL
PLAN VIEW



HARDENED CROSSING DETAIL
CROSS SECTION VIEW
(LOOKING DOWNSTREAM)



CONSTRUCTION NOTES

1. THIS WORK INCLUDES CONSTRUCTION OF A HARDENED CHANNEL CROSSING AT THE LOCATION SHOWN ON SHEET 3.0.
2. THE HARDENED CROSSING LOCATION WILL BE STAKED PRIOR TO CONSTRUCTION.
3. EXCAVATE SLOPE APPROACHES TO CHANNEL TO A MINIMUM DEPTH OF APPROXIMATELY ONE HALF FOOT TO CREATE A UNIFORM SURFACE FOR ROCK PLACEMENT.
4. PLACE 4" CRUSHED ROCK, AS DIRECTED BY PROJECT MANAGER, ON THE SLOPE APPROACHES. BLEND MATERIAL INTO EXISTING GROUND TO ENSURE SMOOTH TRANSITIONS.
5. PLACE 6" MINUS COBBLE ON CHANNEL BED TO A DEPTH OF APPROXIMATELY ONE FOOT.
6. BUCKET COMPACT ROCKY MATERIALS AFTER PLACEMENT ON HARDENED CROSSING SLOPES.

ESTIMATED MATERIAL SCHEDULE

ITEM	QUANTITY	UNIT
6" MINUS COBBLE	APPROX. 3	CY
4" CRUSHED ROCK	APPROX. 5	CY

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HARDENED CHANNEL CROSSING DETAIL

MILLER CREEK LEIK PARCEL RESTORATION PROJECT
MISSOULA, MONTANA

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