BRACKETT CREEK HABITAT IMPROVEMENT AND EROSION CONTROL PROJECT

Application to the Future Fisheries Improvement Program Grant
May 15, 2023

TROUT UNLIMITED

Table of Contents

MONTANA FISH, WILDLIFE & PARKS

Future Fisheries Improvement Program

Application Guidelines

Application Dates:	Submission information:
Deadlines: • November 15 (winter cycle) • May 15 (summer cycle) *Must be received by midnight* **Citizen Review Panel Meetings** for funding recommendations: • Mid-June (summer cycle) • Mid-December (winter cycle) **Fish & Wildlife Commission Meetings** for approval: • August (summer cycle) • February (winter cycle)	**Email to**: FWPFFIP@mt.gov For files over 10MB, use https://transfer.mt.gov and send to mmcgree@mt.gov **Mail to**: Future Fisheries Improvement Program FWP Fisheries Division P.O. Box 200701 Helena, MT 59620 *Digital and printed submissions must be signed*

Comprehensive Program information and guidance can be found at https://fwp.mt.gov/ffip

Program Purpose

To provide funding to enhance, restore, or protect wild fish populations and their habitats. These improvements are intended to benefit fish populations, native species conservation, and angling opportunities.

Project Eligibility

Any individual or group can apply. Projects must evaluate the cause of the problem, incorporate a large-scale view of the project and surrounding area, and benefit the angling public. Project design should incorporate natural stream form and function with the goal of obtaining a condition as close to natural as possible.

Funding Eligibility

Program funds can be used for on-the-ground work, including permitting, construction (and construction oversight), materials, water leasing, and maintenance (up to 10% of the total project cost). Funding cannot be used for administration, travel, coordination, overhead, monitoring, assessment or studies, design alone (must be design/build), contingency, or acquisition of land. Projects must have written landowner permission.

Review Criteria

Project prioritization includes the magnitude of enhancement to aquatic habitats and fish populations, public access and opportunity, waterbody importance, long term effectiveness, cost/benefit, and cost share. Additional emphasis is placed on projects that are in Eastern Montana, involve mineral reclamation, and/or improve native fish.

Available Funding

The Montana Legislature gives authority for the Program to expend funds. Approximately $1.2 million is available for each biennium (two years; four grant cycles). Approved funding varies by grant cycle; over the last five years, the average grant award was approximately $30,000.

Proposed projects should include cost share. A 50% match is typical. In-kind services or wages of government agency personnel cannot be used as match. Permanent irrigation diversions must have at least a 50% match.

The Citizen Review Panel recommends that any project involving grazing includes participation and/or investment from the landowner, including development of a grazing management plan early in the process. Fencing costs should be reasonable and competitive. Photopoints are a required and important part of pre-project and post-project assessment.

FUTURE FISHERIES IMPROVEMENT PROGRAM GRANT APPLICATION

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

I. APPLICANT INFORMATION

A. Applicant Name: Ashley Brubaker

Mailing Address: 321 E Main Street, Suite 401

City: Bozeman State: MT Zip: 59715

Telephone: (303)915-9282 E-mail: Ashley.brubaker@tu.org

B. Contact Person (if different than applicant):

Address:

City: State: Zip:

Telephone: E-mail:

C. Landowner and/or Lessee Name (if different than applicant): Greg and Anne Avis

Mailing Address: PO Box 38

City: Clyde Park State: MT Zip: 59018

Telephone: (650)387-0286 E-mail: gavis@mac.com

II. PROJECT INFORMATION

A. Project Name: Brackett Creek Habitat Improvement and Erosion Control

River, stream, or lake: Stream

Location: Township: 1 N Range: 8 E Section: 3

Latitude: 45.87230 Longitude: -110.72206 *Within project (decimal degrees)*

County: Park

B. Purpose of Project:

Brackett Creek is a tributary of the Shields River that supports a population of Yellowstone Cutthroat Trout and provides cold, clean water to the frequently dewatered Shields. Due to historic land use and an undersized wooden bridge crossing and constricting the channel, Brackett Creek on the Avis Ranch has a high level of instability and many high, eroding banks contributing excess fine sediment to the channel, limiting deep pool habitats, and creating potential for further channel degradation and habitat loss. These impairments are typical of recent conditions throughout Brackett Creek, and various landowners along the creek have implemented restoration projects aimed at stabilizing banks and reducing sediment input (Bockmon and Endicott, 2016). The purpose of this project is to increase watershed resilience, improve floodplain connection, and protect and improve wild and native fish habitat by decreasing bank erosion using a combination of stable channel geometry, native vegetation, and other "soft" techniques. These methods will lead to improved fish habitat for native Yellowstone cutthroat trout, a Montana species of special concern; increased flood resiliency through improved floodplain connections and deep-rooted vegetation; and reduced non-point source sediment input into Brackett Creek, which ranks in the top 10 for sediment intensity from streambank erosion in the Shields watershed, a ranking of sediment per mile of stream (Figure 1) (Shields River Watershed Restoration Plan).

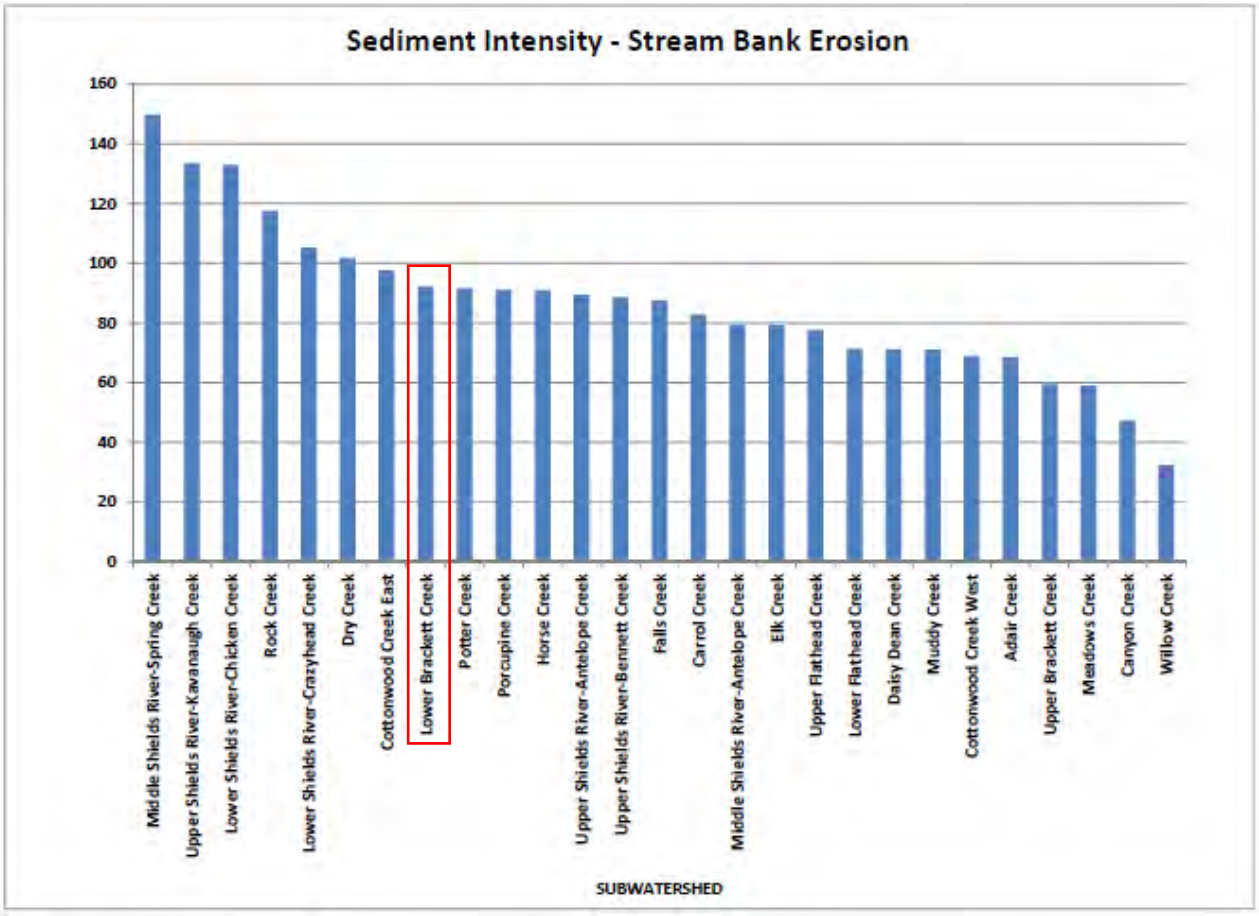


Figure 1 - Estimated sediment intensity from streambank erosion in the Shields watershed from the Shields River Watershed Restoration Plan.

C. Brief Project Description (attach additional information to end of application):

This project will employ a variety of natural bank stabilization and restoration techniques to achieve the outcomes of decreasing erosion, increasing channel stability, and improving aquatic habitat for native and wild fish, including Yellowstone cutthroat trout. This stream reach contains approximately 15 vertical highly eroding banks with a distance from top of bank to bankfull water surface ranging from two to five feet. The vertical faces of these banks are bare soil, making them highly prone to erosion that contributes excess fine sediment to Brackett Creek, degrading fish habitat and contributing sediment to the sediment impaired Shields River. Lateral bank erosion into terrace surfaces occurs throughout the project reach. To combat this erosion, a composite wood toe treatment in conjunction with constructed bankfull benches is proposed to create a stable bank margin. Near-term stability will be provided by a matrix of live and dead wood stems backfilled and compacted with native alluvium. Over time as wood materials degrade, long-term stability will transition to be governed by mature native vegetation. The bankfull bench will serve multiple purposes; it will provide favorable hydrology for establishing riparian vegetation, it will expand the flood prone area, and it will reduce bank height, reducing bank loss due to gravitational collapse.

Throughout the reach, the channel width is appropriate for a C4 Type Channel in some sections, and it is over-widened in others. Where appropriate channel dimensions occur adjacent to terrace erosion, the existing terrace will be excavated to accommodate the composite wood toe treatment and bankfull bench (Scenario 1, shown in red). Where the channel is over-widened adjacent to an eroding terrace, the wood toe treatment will be constructed in the active channel to narrow the channel section (Scenario 2, shown in purple) (Figure 2 and 3). The full conceptual design plan is attached.

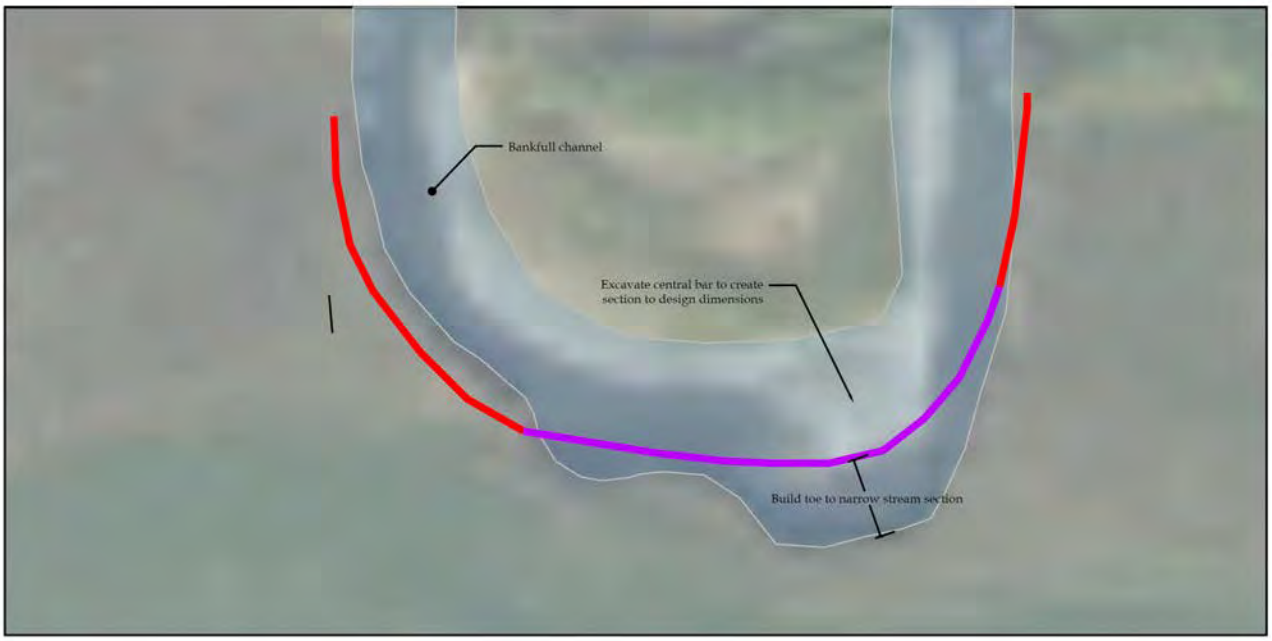


Figure 2 - Plan view restoration example showing Scenario 1 (excavate existing terrace in locations with appropriate channel dimensions) and Scenario 2 (construct wood toe treatment in the active channel to narrow the channel in over-widened locations).

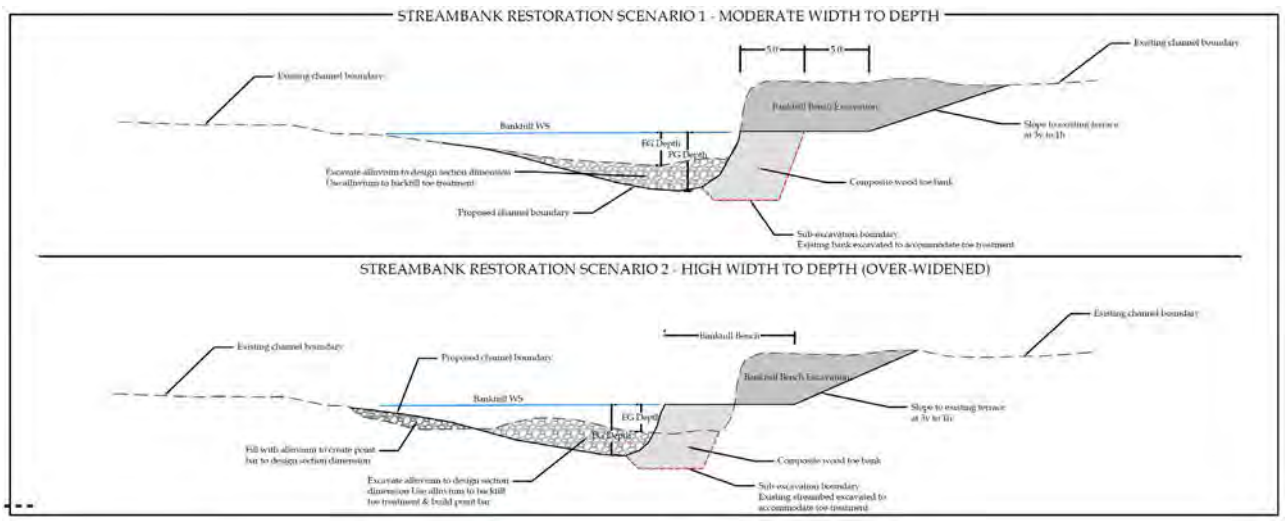


Figure 3 – Cross section view restoration example showing Scenario 1 (excavate existing terrace in locations with appropriate channel dimensions) and Scenario 2 (construct wood toe treatment in the active channel to narrow the channel in over-widened locations).

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

The current channel instability in Brackett Creek is the result of a variety of historic use factors. Prior to the 1990's, the stream was channelized into a straight, single-thread channel that was confined along the base of the county road on the northern edge of the valley bottom. The stream was restored to a historic channel in the 1990s, but haying operations continued on both sides of the stream; this is likely when the wooden bridge was constructed and began causing instability. Haying up to the edge of the channel caused shallow rooted grasses to replace deep-rooted, native vegetation in the riparian zone, leaving the banks vulnerable to erosion during high flow events. This project will remove the constriction caused by the bridge and allow the channel to function more naturally, will enlarge or create a vegetative buffer along the existing hayfield on the south side of the channel, and will further ameliorate instability and erosion by using stable channel geometry and native vegetation to increase bank stability.

E. Length of stream or size of lake that will be treated (project extent): 0.7 miles

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

F. Project Budget Summary:

Grant Request (Dollars):	**$**	**85,115.00**
Matching Dollars:	**$**	**36,000.00**
Matching In-Kind Services:*	**$**	**43,316.00**

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

Other Contributions (not part of this app)	**$**	**12,080.00**
Total Project Cost:	**$**	**176,511.00**

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

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

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

I. Attach project plans:

- [x] Detailed sketches or plan views with the location and proposed restoration
- [x] 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 fish biologist support). List any other project partners:

Letters of support from the landowner and FWP are attached.

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 [x] No [ ]

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

This project is designed to require little to no maintenance once vegetation is established. The project will be monitored for several years after implementation and will be maintained as necessary. After the monitoring period, the landowner will work with Trout Unlimited for any required maintenance.

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.*

Grazing will not be part of or adjacent to the project.

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?

This project will be monitored to determine project success and as required by our permits and funding. Short-term project benefits and lessons learned will be assessed through vegetation monitoring and photo monitoring at established locations. Long-term project benefits and lessons learned will be assessed through photo monitoring.

Pre-project data will be collected and will include erosion hazard index surveys and establishment of photo monitoring points. Fish surveys will be conducted to assess species presence/absence. All monitoring information will be shared with FWP.

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

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

This project will improve habitat and spawning gravels for native Yellowstone cutthroat trout, mountain whitefish and wild brown trout. Rainbow trout and brook trout may be present in the area at very low densities.

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

This project will protect and enhance wild fish habitat and spawning gravels by decreasing erosion, decreasing future channel avulsion, and increasing riparian vegetation. Bank erosion has been identified as one of the primary limiting factors to Yellowstone cutthroat trout in Brackett Creek, and eroding banks contributing fine sediment are abundant on private lands along the creek (Endicott et al., 2012). Excessive fine sediment fills the interstitial spaces between larger channel substrate such as gravels and cobbles, decreasing oxygen availability in coarse substrate and impacting the trout populations by limiting spawning and invertebrate habitat. Decreased erosion will decrease fine sediment input to the channel, improving both spawning habitat and invertebrate habitat.

Ameliorating the current channel instability will decrease the likelihood that the channel will cut off a large meander at the downstream end of the project site, which would shorten the stream length and remove approximately 750 feet of fish habitat from the system. Currently the highest quality fish habitat in the project reach is created around willows and alders along the channel margins. This project will enhance pool habitats vital for overwintering trout. Improving riparian vegetation will increase this type of habitat, will create shade that will maintain cool water temperatures, and will provide fish with cover from overhead predators.

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

In a 2002 study, Confluence Consulting found a limited number of young of the year YCT in Brackett Creek. Their report posited that the low numbers were due to poor spawning habitats caused by a high level of fine sediment (Endicott et al., 2012). Decreasing bank erosion in the project reach will improve spawning gravels in the reach, and potentially in downstream reaches as well. This should lead to an overall increase in YCT present in Brackett Creek and the Shields River in the long term. Additional long-term benefits from this project will include enhanced overhead cover and potentially decreased summer water temperatures due to overhanging branches and shade from mature riparian vegetation. Short term benefits include benefits from decreased erosion and fine sediment input such as improved spawning gravels and invertebrate habitat, leading to a larger and healthier fish population in Brackett Creek and the Shields River, and improved angler success.

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.

The benefits of this project will extend beyond the project reach and will increase the opportunity to catch a wild trout through bolstering the wild trout population in Brackett Creek and the Shields River. While there is no public fishing access within the project reach, anglers can legally access Brackett Creek just downstream of the project area. Improving the fishery here will translate to improved fisheries throughout Brackett Creek and into the Shields. Anglers at public access points on the Shields River could very well catch a fish that was spawned in or has spent time in the project reach.

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

This project is designed to continue to improve overall watershed health and resiliency beyond fish habitat. Fortunately, what is good for the fish is typically good for the watershed, and this is the case in Brackett Creek. The landowners and Trout Unlimited are committed to the health of Brackett Creek and the Shields Watershed as demonstrated through a water lease near the project reach from the landowners and held by TU for over a decade. This project aims to build on the instream flow improvements and remedy the causes of the channel instability and erosion, thereby restoring natural function and processes to the stream, in turn improving overall stream health and resiliency. The Shields River at the confluence with Brackett Creek is chronically dewatered resulting in high mid-summer water temperatures. Through restored habitat, streamflow, and water quality, Brackett Creek provides thermal refuge and spawning habitat for Shields River fish populations. By decreasing erosion and increasing riparian vegetation this project will benefit other aquatic and terrestrial animals. Aquatic invertebrates will benefit from improved habitat in interstitial spaces and increased leaf litter and other detritus in the stream, birds will benefit from increased habitat and food availability in the form of insects and fish, and mammals such as beaver, deer, moose, muskrat, and bears will benefit from improved habitat and food sources. This project leverages improving fish habitat and angler opportunity as a means to improve all aspects of the riparian system.

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

This project will not interfere with water or property rights of adjacent landowners.

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

This project will not result in the development of commercial recreational use on the site.

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

This project is not associated with the reclamation of past mining activity.

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: _____ Date: 11/15/2022

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

Citations

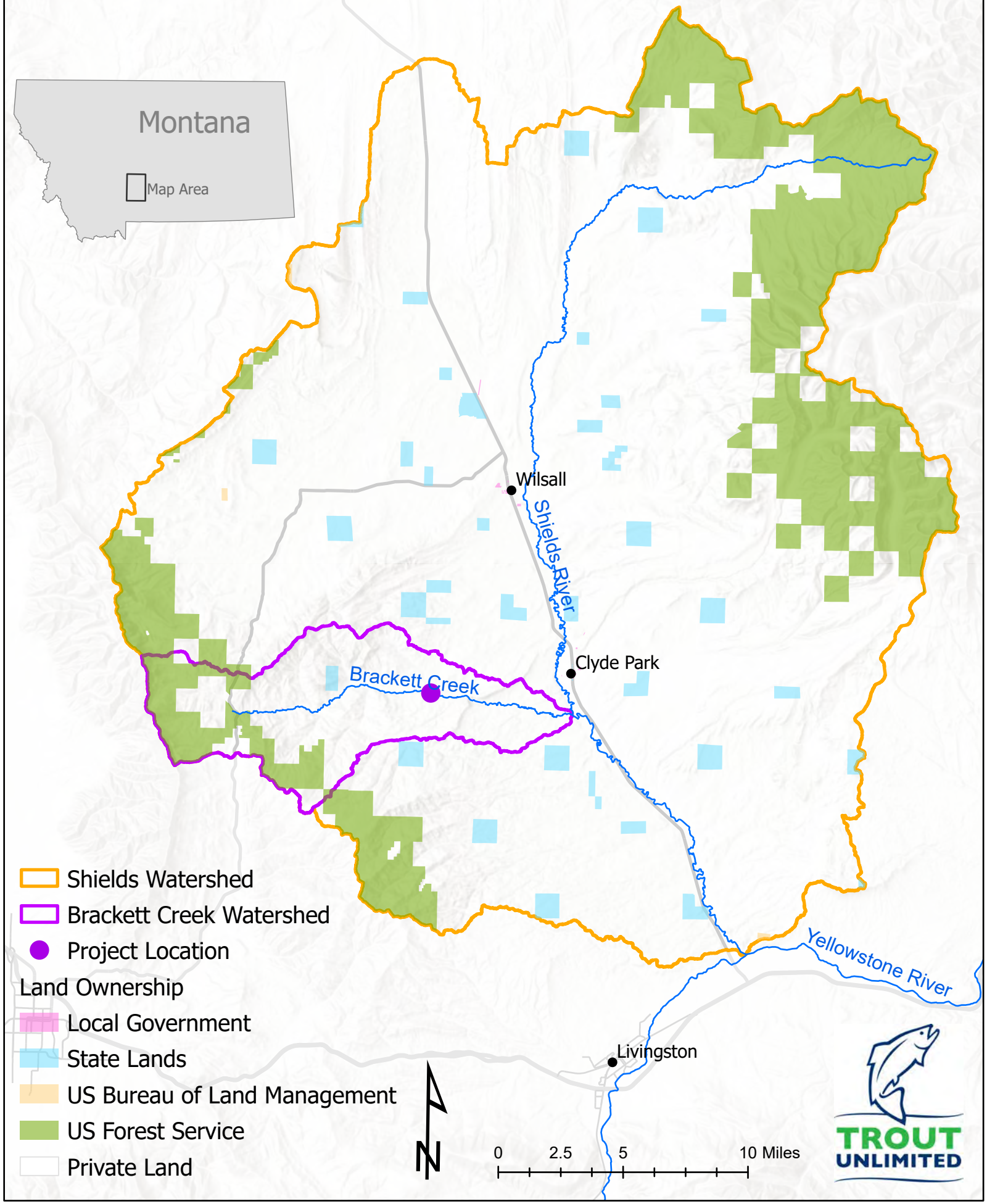
Bockmon, S, and Endicott, C.L. 2016. Future Fisheries Improvement Program Monitoring, 2016. Montana Fish, Wildlife, and Parks, Livingston Fisheries Office, Livingston, Montana.

Confluence Consulting, inc., 2012. Watershed Restoration Plan for Shields River Watershed. Prepared for the Shields Valley Watershed Group, Livingston, Montana.

Endicott, C.L., S. Opits, B. Shepard, P. Byorth, S. Shuler, S. Barnde, B. Roberts, L. Roulson. 2012. Yellowstone cutthroat trout conservation strategy for the shields river watershed above Chadbourne diversion, 2012. Montana Fish, Wildlife & Parks, Helena, Montana.

Brackett Creek Project Location

Brackett Creek streambank restoration 01.2-2023



Brackett Creek Habitat Improvement and Erosion Control Plan View

Brackett Creek stream bank restoration

DWG-2023

Pre-project Photographs

45.87225, -110.72362

45.87231, -110.72261

45.87240, -110.72141

45.87183, -110.72021

Ashley Brubaker
Upper Yellowstone-Shields Project Manager
Trout Unlimited
321 E Main St. Suite 411
Bozeman, Mt 59715

November 4, 2022

Re: Brackett Creek

Dear Ashley Brubaker,

Montana Fish, Wildlife & Parks (FWP) appreciates the opportunity to comment on this stream restoration project on Brackett Creek.

FWP supports the proposed bank stabilization and restoration on Bracket Creek. This includes the removal of the bridge that is no longer needed, increasing and improving the riparian vegetation on eroding banks, and re-sloping of vertical banks to stabilize channel geometry. We believe these efforts will improve stream form and function, reduce sediment deposition, and improve habitat for native Yellowstone cutthroat and brown trout in Brackett Creek.

For further questions or concerns, please reach out to the following FWP personnel: Scott Opitz, Fisheries Biologist (phone:406-223-3951, email: sopitz@mt.gov)

Sincerely,

Marina Yoshioka
Region 3 Supervisor

Future Fisheries Coordinator
Montana Fish, Wildlife & Parks
Fisheries Division
1420 E. Sixth Ave.
P.O. Box 200701
Helena, MT 59620-0701

November 15, 2022

Dear Future Fisheries Coordinator and Review Panel,

I am writing in support of Trout Unlimited's Brackett Creek Habitat Improvement and Erosion Control Project application to the Future Fisheries Improvement Program grant. This project will improve Brackett Creek fish habitat, decrease bank erosion, and improve the overall resiliency of the stream using minimally disruptive methods. Our family has supported Trout Unlimited for over 10 years and has partnered with them to maintain instream flows through water leases in Brackett, Bangtail, and Canyon Creeks. We have had many conversations about our shared goals to improve fish habitat and watershed resiliency and are pleased to partner with them on a stream restoration and habitat improvement project on our ranch. We will support this project by donating funds and materials to decrease sediment input to the stream from heavily eroding banks and to increase native riparian vegetation. The completed project will provide long-lasting improvements to wild and native trout habitat and support a robust fishery in the Shields River. We thank you for considering this project for funding.

Sincerely,

Greg Avis

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	1	survey and wetland delineation	$2,500.00	$ 2,500.00		2,500.00		$ 2,500.00
Design and engineering	1	consultant design	$30,000.00	$ 30,000.00	3,200.00	26,800.00		$ 30,000.00
Permitting	40	Hours	$45.00	$ 1,800.00	1,800.00			$ 1,800.00
Oversight	40	Hours	$45.00	$ 1,800.00	1,800.00			$ 1,800.00
TU Staff Time	140	Hours	$45.00	$ 6,300.00		6,300.00		$ 6,300.00
			Sub-Total	$ 42,400.00	$ 6,800.00	$ 35,600.00	$ -	$ 42,400.00
Travel								
Mileage	1000	mile	$0.68	$ 680.00		680.00		$ 680.00
Per diem				$ -				$ -
			Sub-Total	$ 680.00	$ -	$ 680.00	$ -	$ 680.00
Construction Materials****								
Containerized Shrub Plantings	1040	Stems	$8.00	$ 8,320.00			8,320.00	$ 8,320.00
Wet Riparian Seed Mix	10	pounds	$26.00	$ 260.00			260.00	$ 260.00
Wood Collection	7800	stems	$2.00	$ 15,600.00		15,600.00		$ 15,600.00
Live Willow Stems	7800	Stems	$2.00	$ 15,600.00		15,600.00		$ 15,600.00
			Sub-Total	$ 39,780.00	$ -	$ 31,200.00	$ 8,580.00	$ 39,780.00
Equipment, Labor, and Mobilization								
Bulk Excavation	6320	cubic yards	$4.50	$ 28,440.00	28,440.00			$ 28,440.00
Soil Disposal	5075	cubic yards	$5.00	$ 25,375.00	18,675.00	6,700.00		$ 25,375.00
Bank Construction	2080	linear feet	$15.00	$ 31,200.00	31,200.00			$ 31,200.00
TU Staff labor	50	hours	$45.00	$ 2,250.00		2,250.00		$ 2,250.00
Volunteers	150	person hours	$19.24	$ 2,886.00		2,886.00		$ 2,886.00
Bridge Removal	1	bridge	$3,500.00	$ 3,500.00			3,500.00	$ 3,500.00
			Sub-Total	$ 93,651.00	$ 78,315.00	$ 11,836.00	$ 3,500.00	$ 93,651.00
			TOTALS	$ 176,511.00	$ 85,115.00	$ 79,316.00	$ 12,080.00	$ 176,511.00

BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS

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 must include a justification or minimum of two competitive bids for the cost of undertaking the project.

****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: ** In-kind labor justification: TU staff time for this particular project will be billed to an unrestricted project fund, rate is loaded employee rate/hr. Volunteer hourly rate is based on 2021 State Occupational Employment and Wage Estimates for Montana (https://www.bls.gov/oes/current/oes_mt.htm#45-0000). The mean rate for "Farming, Fishing, and Forestry Occupations" was used in calculations = $19.24.

APPLICATION MATCHING CONTRIBUTIONS

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

CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
Trout Unlimited	$ 9,230.00	$ -	$ 9,230.00	Y
Landowner	$ 31,200.00	$ 26,000.00	$ 57,200.00	Y
Volunteers	$ 2,886.00	$ -	$ 2,886.00	N
Embrace a Stream Grant		$ 10,000.00	$ 10,000.00	N
TOTALS	$ 43,316.00	$ 36,000.00	$ 79,316.00	

OTHER CONTRIBUTIONS

(contributions not associated with the application)

CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
Bridge Demolition - 3rd party	$ -	$ 3,500.00	$ 3,500.00	N
Plants and Seed - TU Local Chapters	$ -	$ 8,580.00	$ 8,580.00	N
TOTALS	$ -	$ 12,080.00	$ 12,080.00	

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

PROJECT LOCATION

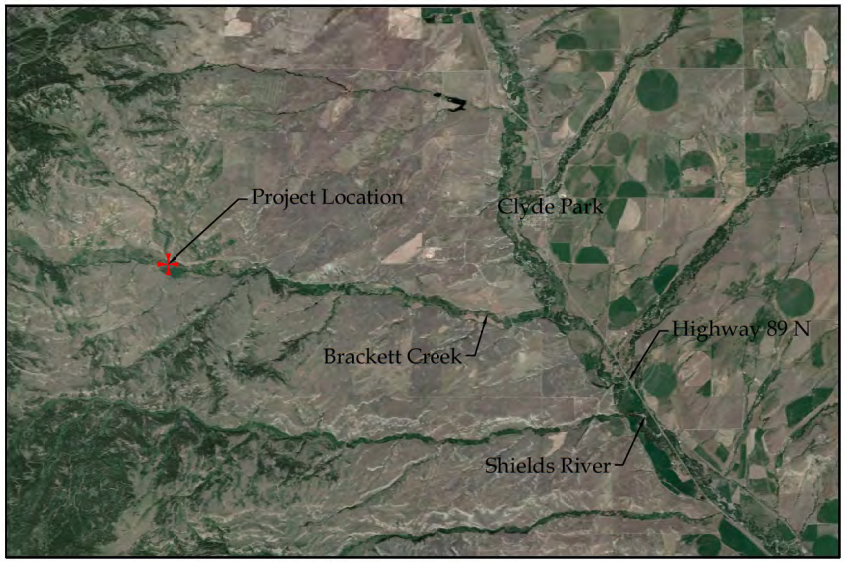
LOCATED IN PARK COUNTY AT 545 BRACKETT CREEK ROAD, CLYDE PARK, MONTANA

AT

S ½ SW ¼ SW ¼ OF SECTION 34, N ½ NW ¼ NW ¼ OF SECTION 3, AND N ½ , NE ¼ & NW ¼ OF SECTION 3, TWP 2N, RANGE 8E

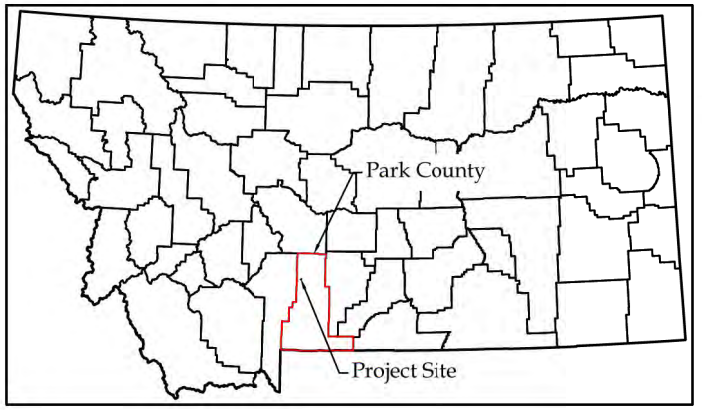
LATITUDE = 45° 52' 20" NORTH; LONGITUDE = 110° 43' 20" WEST

PROJECT SPONSOR: MONTANA TROUT UNLIMITED



PROJECT SITE MAP

Scale: 1" = 5,000'



VICINITY MAP

SHEET INDEX:

RESTORATION ENGINEERING LLC
Aquatic Restoration and Environmental Hydraulics

VICINITY MAP AND SHEET INDEX

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

MONTANA TROUT UNLIMITED

NO.	DATE	DESCRIPTION

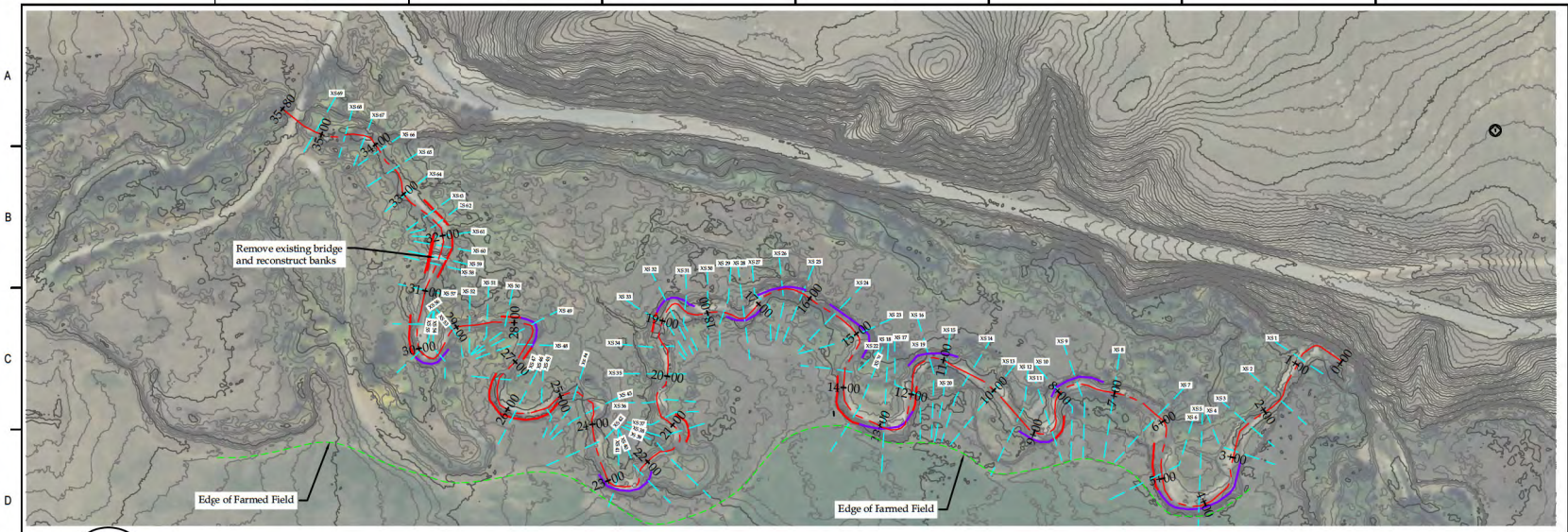
PROJECT NO: 0622-01

DESIGNED: TC DRAWN: TC CHECKED:

PROJECT NO.:

DATE: 5/9/2023

FIGURE: 1

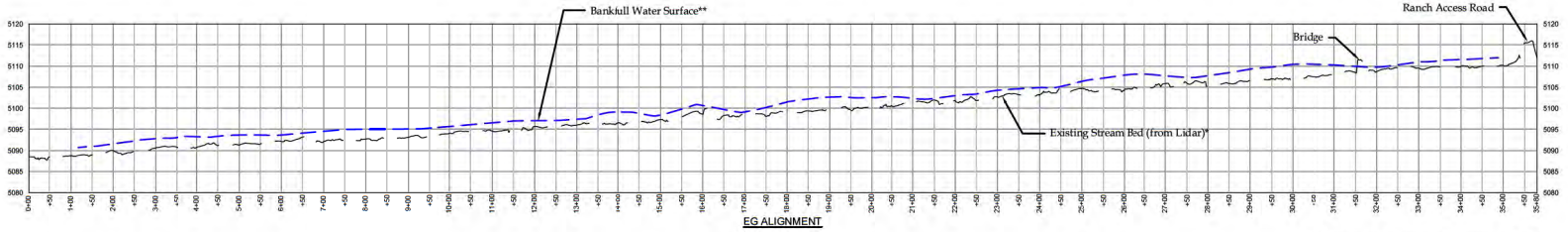


0 200 400 Feet

Proposed Bank Treatment Lengths	
Composite Wood Toe - Scenario 1	890 Feet
Composite Wood Toe - Scenario 2	1190 Feet

Cross Sections

Channel Centerline Alignment



*CPS Survey of the channel will be completed when runoff conditions allow
**Approximated from a HEC RAS model using lidar generated geometry. Lacks in-channel detail

RESTORATION ENGINEERING LLC
Aquatic Restoration and Environmental Hydraulics

PLAN & PROFILE VIEW

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

MONTANA TROUT UNLIMITED

NO.	DATE	DESCRIPTION

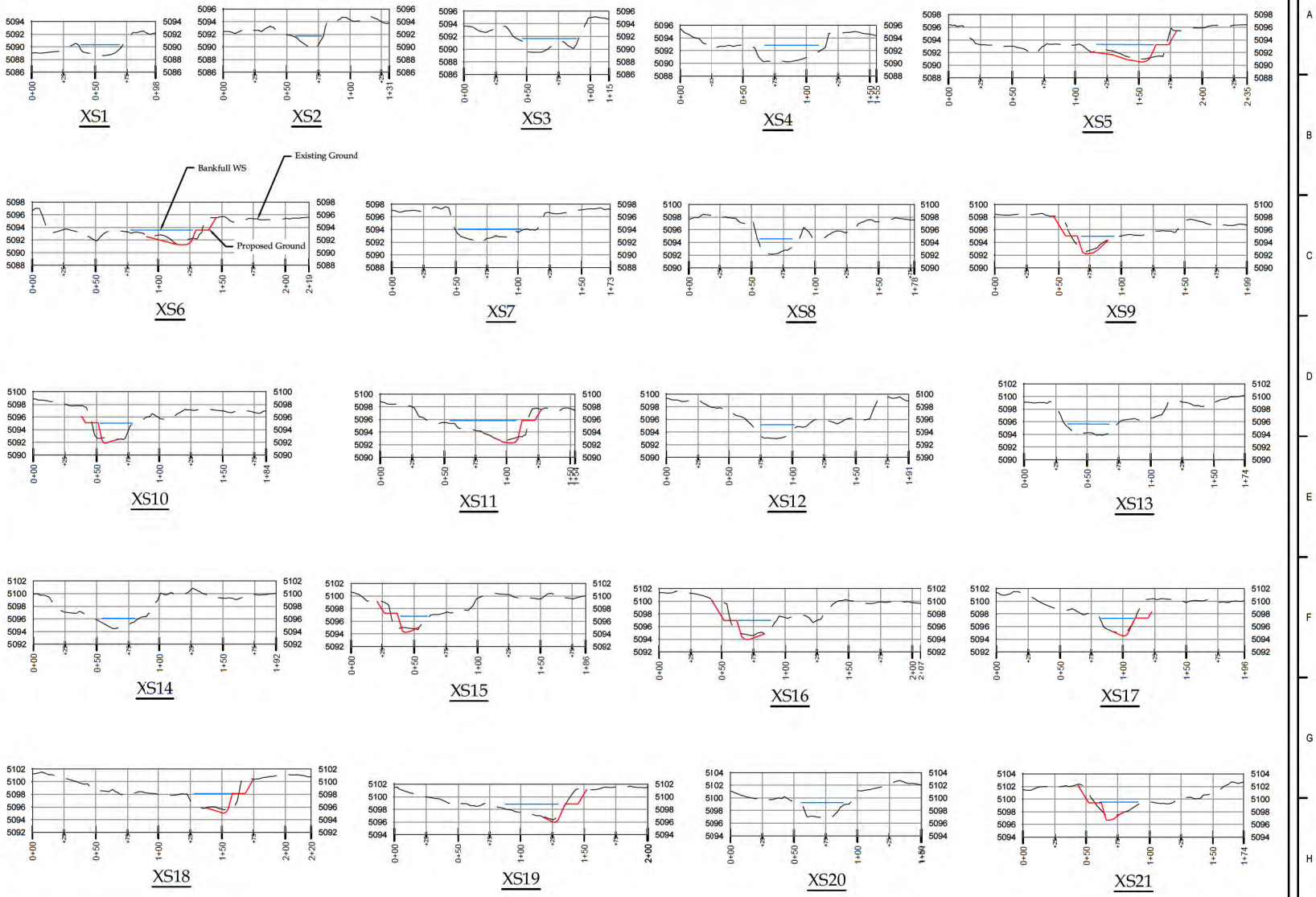
PROJECT NO: 0323-2

DESIGNED: TC DRAWN: TC CHECKED:

PROJECT NO.:

DATE: 05/9/23

SHEET NO.: 2



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CROSS SECTIONS 1 - 21

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

MONTANA TROUT UNLIMITED

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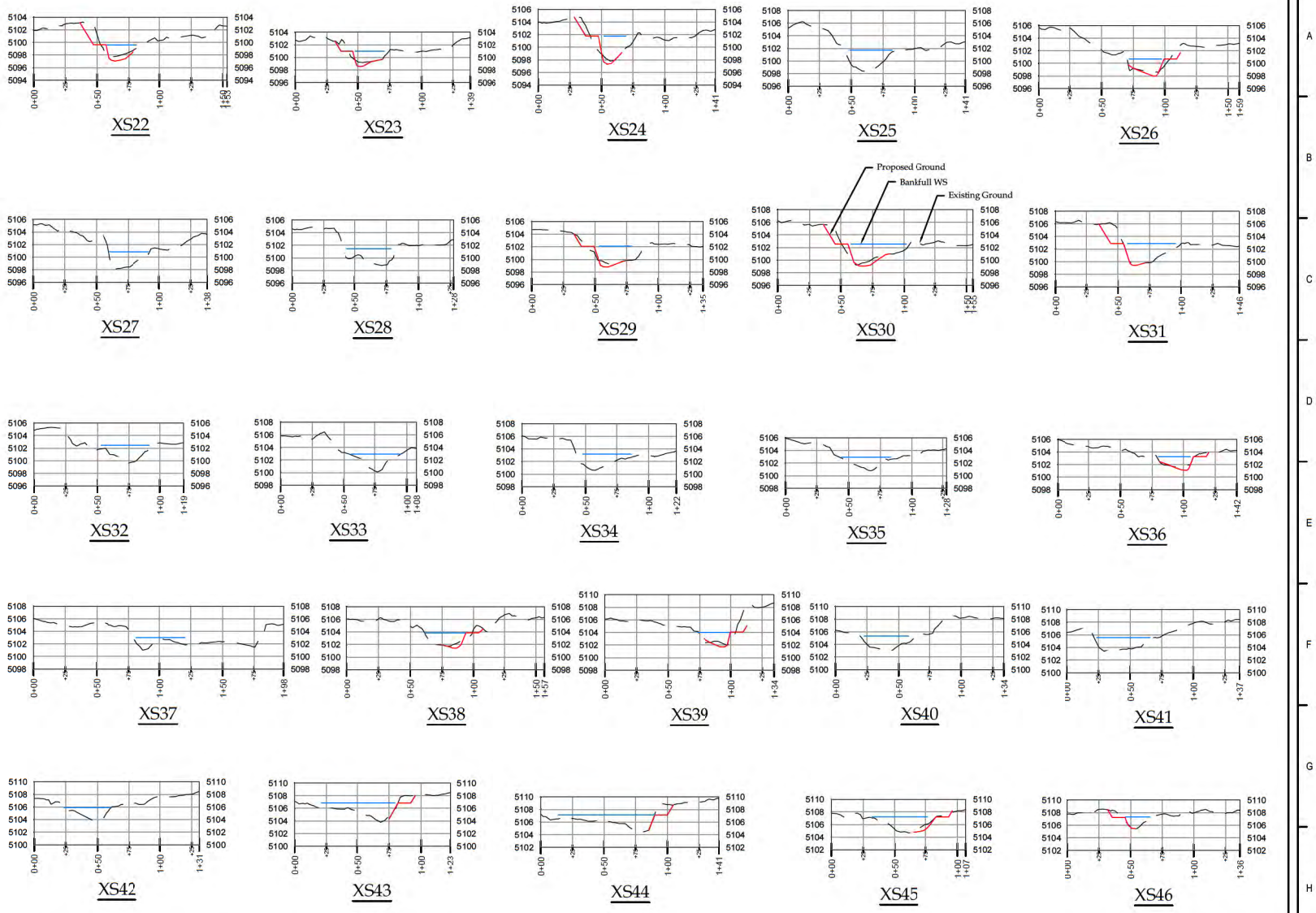
SHEET NO.: 3



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CROSS SECTIONS 22 - 46

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

MONTANA TROUT UNLIMITED

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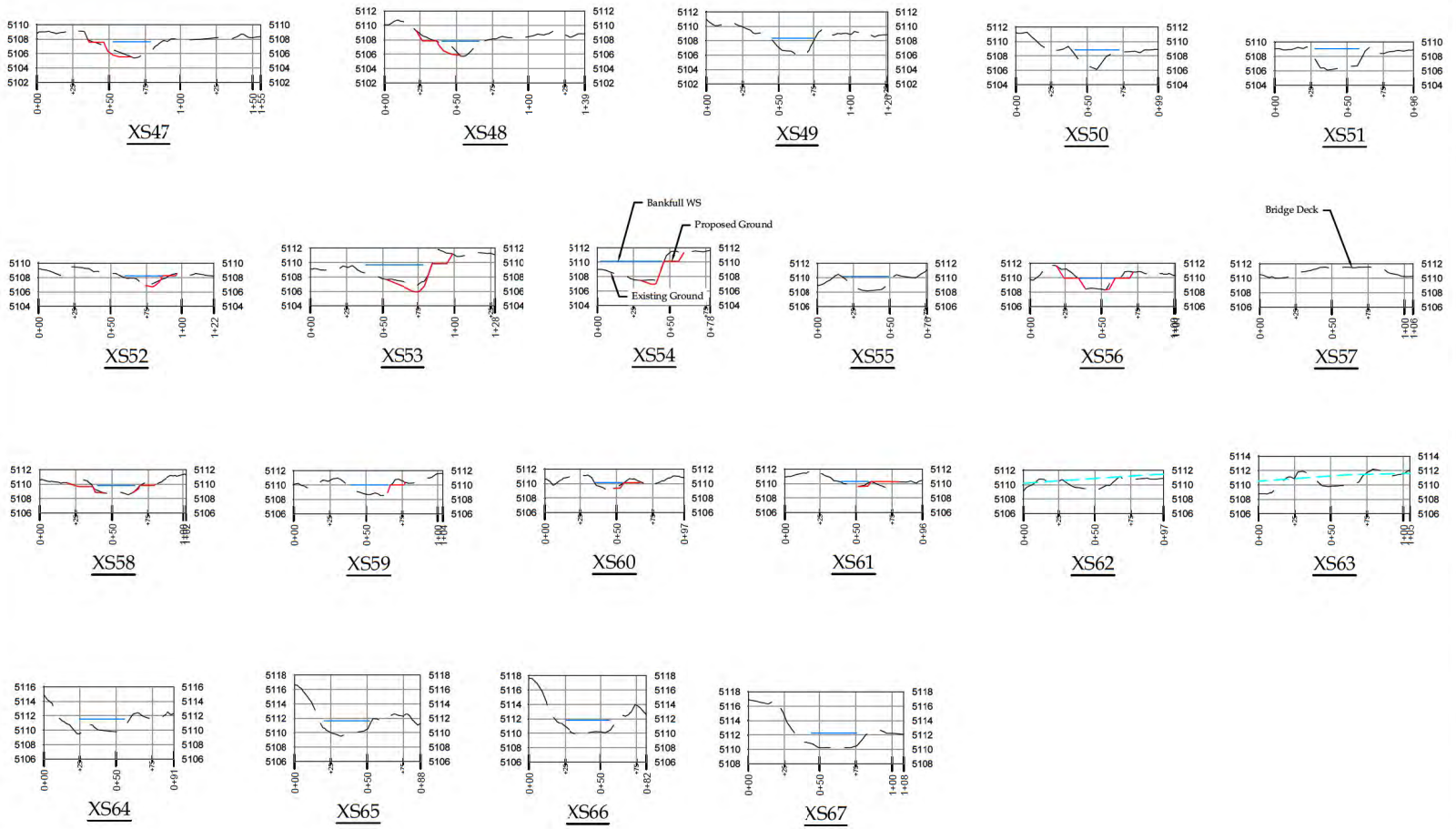
SHEET NO.: 4



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CROSS SECTIONS 47 - 67

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

MONTANA TROUT UNLIMITED

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PROJECT NO: 0323-2

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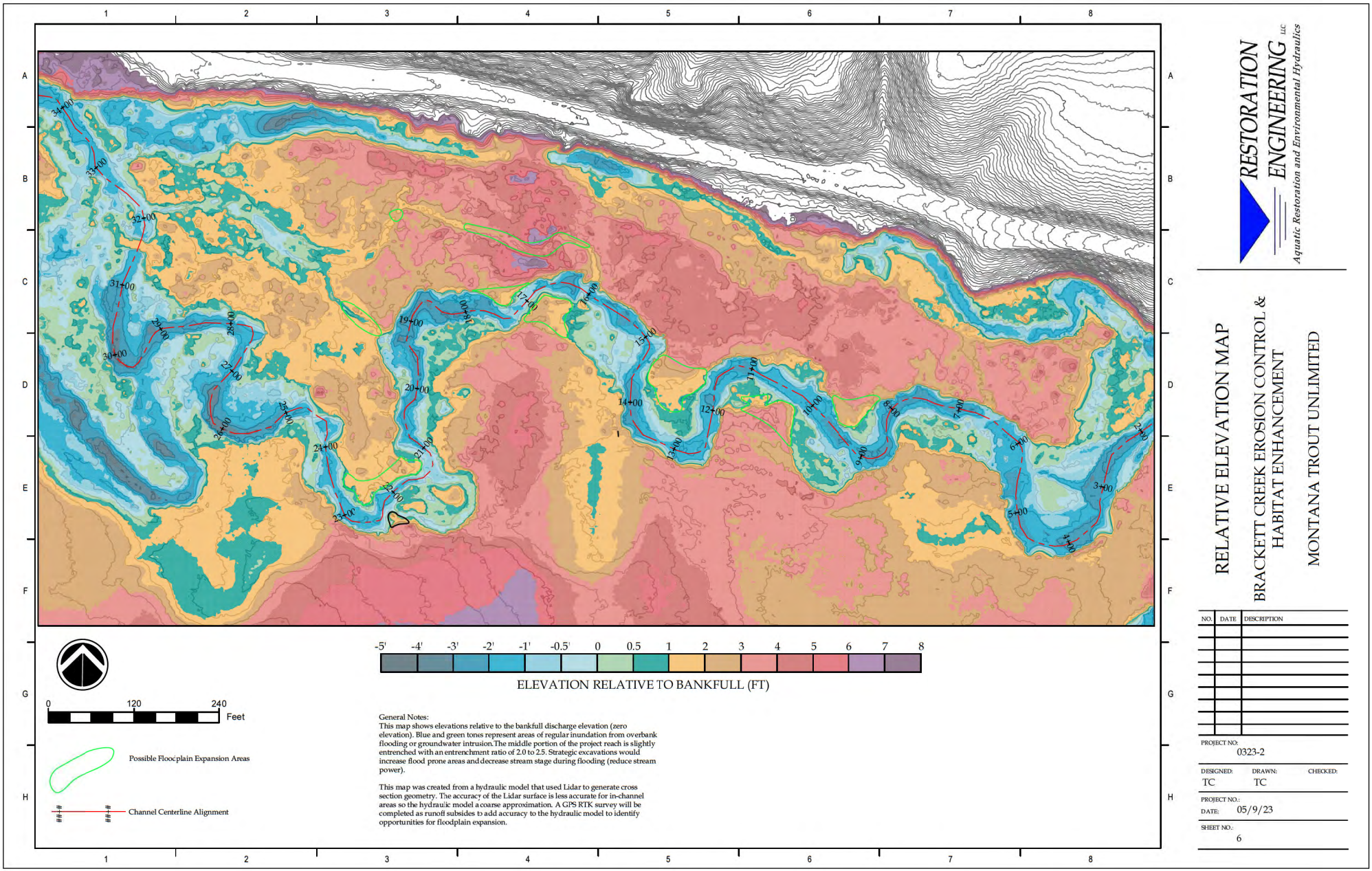
PROJECT NO.:

DATE: 05/10/23

SHEET NO.: 5



General Notes:
This map shows elevations relative to the bankfull discharge elevation (zero elevation). Blue and green tones represent areas of regular inundation from overbank flooding or groundwater intrusion.The middle portion of the project reach is slightly entrenched with an entrenchment ratio of 2.0 to 2.5. Strategic excavations would increase flood prone areas and decrease stream stage during flooding (reduce stream power).

This map was created from a hydraulic model that used Lidar to generate cross section geometry. The accuracy of the Lidar surface is less accurate for in-channel areas so the hydraulic model a coarse approximation. A GPS RTK survey will be completed as runoff subsides to add accuracy to the hydraulic model to identify opportunities for floodplain expansion.

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RELATIVE ELEVATION MAP

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

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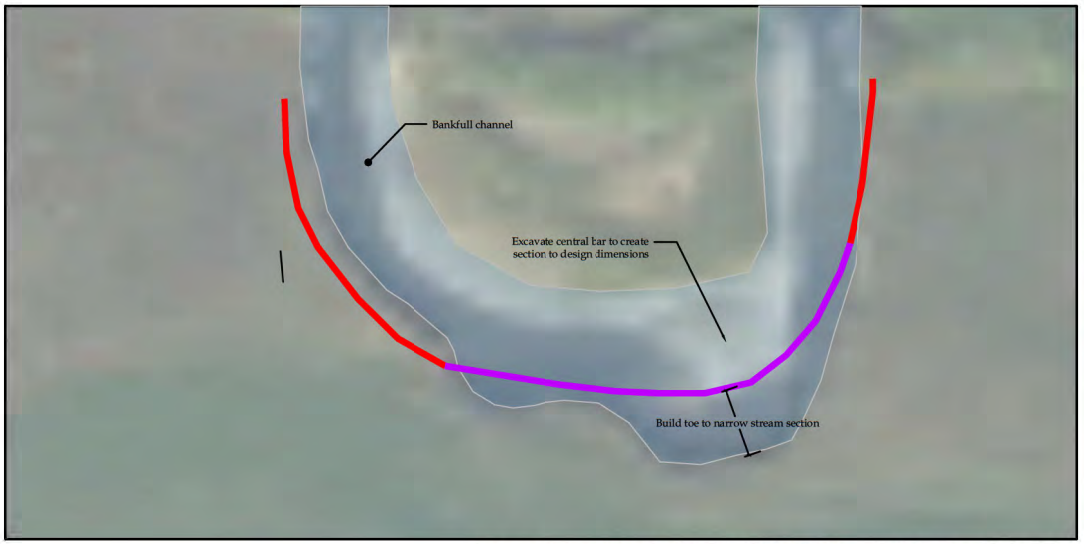
SHEET NO.: 6



STREAMBANK RESTORATION - TYPICAL PLAN VIEW

General Notes:
Lateral bank erosion into terrace surfaces occurs throughout the project reach. A composite wood toe treatment in conjunction with a constructed bankfull bench is proposed to create a stable bank margin. Near term stability is provided by a matrix of live and dead wood stems backfilled and compacted with native alluvium. Over time as wood materials degrade, long term stability will transition to be governed by mature native vegetation. The bankfull bench serves multiple purposes. It provides favorable hydrology for establishing riparian vegetation, it expands the flood prone area and it reduces bank height, reducing bank loss due to gravitational collapse.

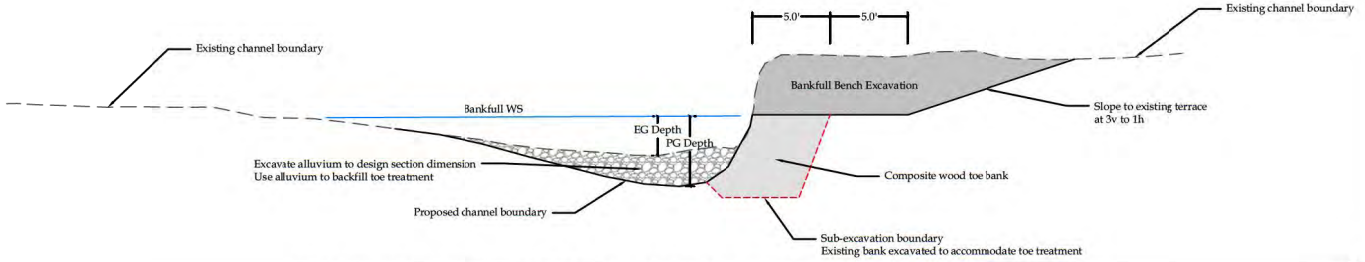
Though the reach, the channel width is appropriate for a C4 Type Channel in some reaches and it is over-widened in others. Where appropriate channel dimensions occur adjacent to terrace erosion the existing terrace will be excavated to accommodate the composite wood toe treatment and bankfull bench (Scenario 1). Where the channel is over-widened adjacent to an eroding terrace the wood toe treatment will be constructed in the active channel to narrow the channel section (Scenario 2).

STREAMBANK RESTORATION SCENARIO 1

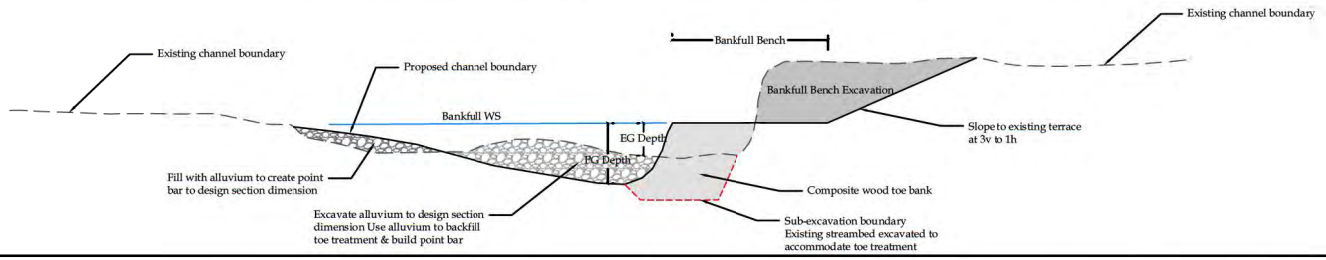
STREAMBANK RESTORATION SCENARIO 2

0 30 60 Feet

STREAMBANK RESTORATION SCENARIO 1 - MODERATE WIDTH TO DEPTH



STREAMBANK RESTORATION SCENARIO 2 - HIGH WIDTH TO DEPTH (OVER-WIDENED)



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BANK RESTORATION SCENARIOS

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

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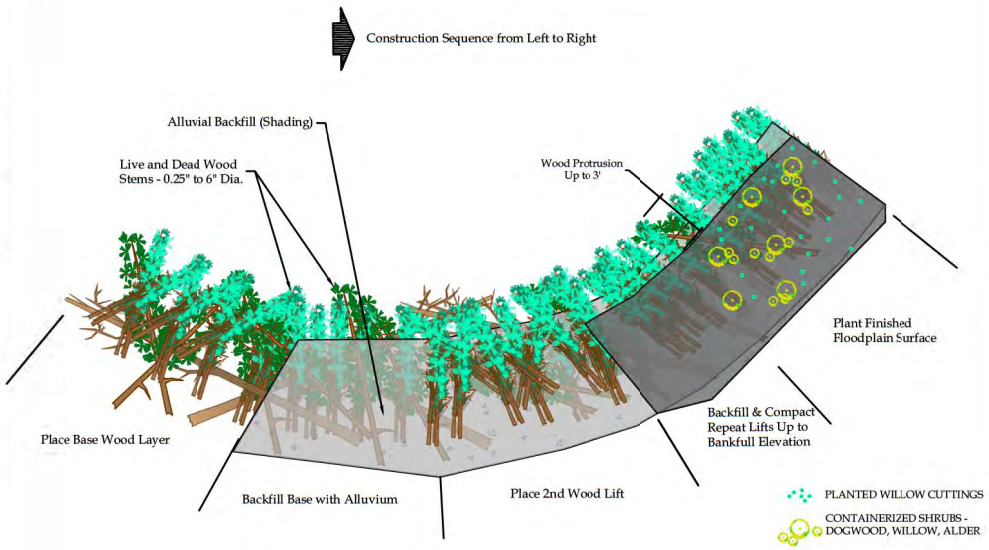
SHEET NO.: 7

COMPOSITE WOOD TOE PLAN VIEW DETAIL

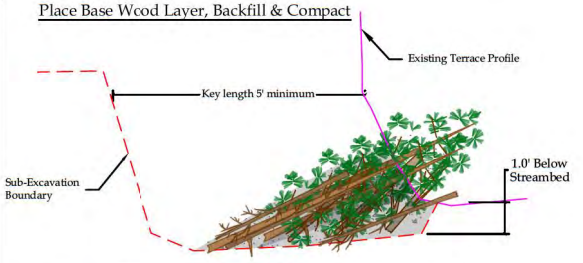


Composite Wood Toe Construction - Typical Installation

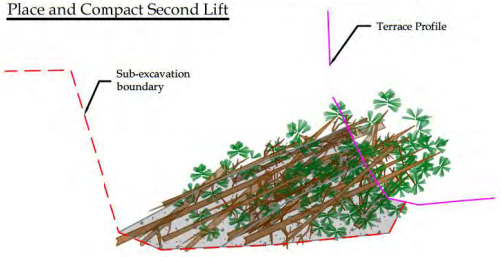
WOOD TOE BANK CONSTRUCTION SEQUENCE:

1. Compcsite wood toe banks shall be constructed in lifts with large and small wood stems from 0.25" to 6.0" in diameter and 3 to 10 feet in ength.
2. Larger stems can be used as base logs and within the wood toe matrix.
3. Stems may be both live and dead wood.
4. Compcsite wood toe banks shall be keyed laterally into channel banks a minimum 5 feet.
5. Stems shall be placed in 1' - 1.5' lifts at a density of approximately 5 - 10 stems per lineal foot of bank.
6. Stems shall be placed at a variety of orientations to the flow direction.
7. Each wood toe lift shall be backfilled with alluvial gravels per material specification.
8. Backfilled lifts will be bucket compacted until the lift is firm and unyielding.
9. Placement and compaction of lifts shall be repeated until the finished bank height is achieved.
10. Lifts shall be constructed so that brush and live willow stems angle back into the bank as shown.
11. Live stems should protrude from the face and top of the constructed bank with at least 2-lateral stem buds exposed.
12. Flexible stems shall be placed so that they protrude into the channel 1' to 3' at a density that provides full coverage of the finished bank surface.

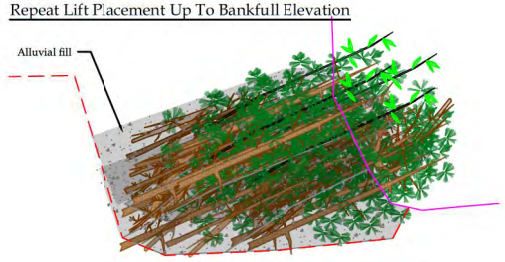
Place Base Wood Layer, Backfill & Compact



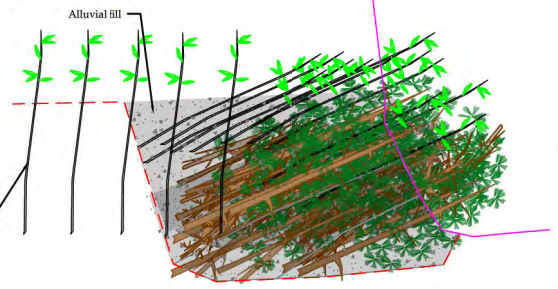
Place and Compact Second Lift



Repeat Lift Placement Up To Bankfull Elevation



Fill to Final Elevation and Plant Floodplain Surface



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COMPOSITE WOOD TOE CONSTRUCTION

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SHEET NO.: 8

MATERIAL QUANTITIES & ESTIMATED COSTS

DESCRIPTION	QUANTITY	UNITS	UNITS COST	TOTAL ESTIMATED COST
Bulk Excavation	6,320	YD^3	$4.50	$28,440.00
Soil Disposal	5,075	YD^3	$5.00	$25,375.00
Bank Construction	2,080	LF	$15.00	$31,200.00
Bridge Removal	1	LS	$3,500.00	$3,500.00
Wood Collections	7,800	STEMS	$2.00	$15,600.00
Live Willow Collection	7,800	STEMS	$2.00	$15,600.00
Containerized Shrub Plantings	1,040	STEMS	$8.00	$8,320.00
Wet Riparian Seed Mix	10.00	LBS	$26.60	$266.00
			TOTAL	**$128,301.00**

Containerized Tree & Shrub Species List
Species
Alder (*Alnus incana*)
Narrowleaf Cottonwood (*Populus angustifolia*)
Red Osier Dogwood (*Cornus sericea*)
Bebb Willow (*Salix bebbiana*)

Sizes vary depending on availability

Riparian Seed Mix
Species
Baltic Rush (*Juncus balticus*)
Bluejoint Reedgrass (*Calamagrostis canadensis*)
Tufted Hair Grass (*Deschampsia cepitosa*)
Blue Wildrye (*Elymus glaucus*)
Nebraska Sedge (*Carex nebrascensis*)
Mountain Bromegrass (*Bromus marginatus*)
Slender Wheatgrass (*Elymus trachycaulus*)
Western Wheatgrass (*Pascopyrum smithii*)
Beaked Sedge (*Carex rostrata*)
Western Yarrow (*Achillea millefolium*)

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Aquatic Restoration and Environmental Hydraulics

MATERIAL QUANTITIES & COSTS

BRACKETT CREEK EROSION CONTROL & HABITAT ENHANCEMENT

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SHEET NO.: 9