2022 319 Application Form - General and Focus Watershed

**********REVISED 10/22/2021**********

General Information

Project Name: Miller and O'Brien Creeks Sediment Reduction and Restoration

Sponsor Name: Clark Fork Coalition

Registered with the Secretary of State? Y

Registered with SAM? Y

Duns #: 840737332

Does your organization have liability insurance? Y

Primary Contact	Jed Whiteley
Title	Project Manager
Address	140 S 4th St W #1
City	Missoula
State	MT
Zip Code	59801
Phone Number	406-531-0256
Email Address	jed@clarkfork.org
Signature	Jed Whiteley Digitally signed by Jed Whiteley Date: 2021.10.28 10:17:40 -06'00'

Signatory	Karen Knudsen
Title	Executive Director
Address	140 S 4th St W #1
City	Missoula
State	MT
Zip Code	59801
Phone Number	406-542-0539 ext 203
Email Address	karen@clarkfork.org
Signature	Karen Knudsen Digitally signed by Karen Knudsen Date: 2021.10.28 10:18:28 -06'00'

Technical and Administrative Qualifications

CFC brings an experienced technical and grant management team to these projects and a proven track record of performance on government funded projects during its 33 year history. CFC's Bring back the Bitterroot campaign is led by CFC's PM Jed Whiteley. Jed has completed over $10 million dollars of restoration projects in Western Montana and the Idaho Panhandle. He is Rosgen Level III certified with 20 years experience in heavy equipment stream restoration. Adam Switalski and Katie Racette round out CFC's Bitterroot project management team with over 28 years of restoration experience between them. The Lolo NF brings a team of hydrologists, biologists, engineers and soil scientists to the project for planning and design, permitting and construction oversight.

Past Projects

Project Name	Grant or Contract Amount	Funding Entity *(entity name/program, contact person, phone, email)*	Completion Date
Lolo Ditch Fish Screen	$ 105,000.00	USFWS/ CFDA Program George Jordan 406-247-7365, george_jordan@fws.gov	December 2020
Lower Bitterroot Tributary Restoration	$ 293,000.00	Montana DEQ/319 Mark Ockey 406-461-6737, Mockey@mt.gov	December 2022
Miller Creek Restoration	$ 28,000.00	FWP Future Fisheries Michelle McGree 406-444-2432, mmcgree@mt.gov	December 2019

Budget Summary: *Fields outlined in black on this page will auto-populate from other sections of the application form. Fields outlined in red on this page will not auto-populate. You must manually input the information for fields outlined in red.*

	319 Funding Request	Non-Federal Match	Federal Match	Other Funding	Total Cost
Education and Outreach Project	$ 5,000	$ 3,000	$ 0	$ 0	$ 8,000
Administration	$ 20,000	$ 5,000	$ 0	$ 0	$ 25,000
Project 1 Name	O'Brien Creek Meadows Restoration				
Project Planning & Oversight	$ 4,000	$ 2,700	$ 0	$ 0	$ 6,700
Landowner Agreements, O & M	$ 500	$ 500	$ 0	$ 0	$ 1,000
Project Implementation	$ 60,000	$ 55,500	$ 0	$ 0	$ 115,500
Other Activities	$ 0	$ 0	$ 0	$ 0	$ 0
Project Effectiveness Monitoring	$ 4,000	$ 2,000	$ 0	$ 0	$ 6,000
Total	$ 68,500	$ 60,700	$ 0	$ 0	$ 129,200
Project 2 Name	Upper O'Brien Creek Stream Restoration				
Project Planning & Oversight	$ 18,000	$ 12,000			$ 30,000
Landowner Agreements, O & M	$ 200	$ 200			$ 400
Project Implementation	$ 54,000	$ 36,000	$ 10,000		$ 100,000
Other Activities					$ 0
Project Effectiveness Monitoring	$ 4,000	$ 2,000			$ 6,000
Total	$ 76,200	$ 50,200	$ 10,000	$ 0	$ 136,400
Project 3 Name	Miller Creek Mile 7 Restoration				
Project Planning & Oversight	$ 18,000	$ 12,000			$ 30,000
Landowner Agreements, O & M	$ 500	$ 500			$ 1,000
Project Implementation	$ 56,000	$ 34,000			$ 90,000
Other Activities					$ 0
Project Effectiveness Monitoring	$ 4,000	$ 2,000			$ 6,000
Total	$ 78,500	$ 48,500	$ 0	$ 0	$ 127,000
Project 4 Name					
Project Planning & Oversight					$ 0
Landowner Agreements, O & M					$ 0
Project Implementation					$ 0
Other Activities					$ 0
Project Effectiveness Monitoring					$ 0
Total	$ 0	$ 0	$ 0	$ 0	$ 0
Grand Total	$ 248,200	$ 167,400	$ 10,000	$ 0	$ 425,600

Education and Outreach

DEQ recognizes that developing good projects often requires a considerable amount of time and effort up front to build relationships and trust with individual landowners and stakeholder groups. To promote the development of future projects, DEQ is encouraging project sponsors to use up to $5,000 in 319 funding for education and outreach to develop and capitalize on these critical relationships. DEQ encourages applicants to incorporate on-the-ground projects into education and outreach efforts through on-site demonstrations and project tours. 319 funding may not be used to pay for food and beverages, or for honorariums and gifts. Education and outreach activities funded by 319 or used as match for 319 funding must adhere to all of the eligibility requirements outlined in the annual Call for Applications document.

Education and Outreach Deliverables *(Identify the education and outreach activities you will engage in and methods you will use to document their completion.)*

After years of project experience we have learned that one-on-one outreach with landowners is unparalleled for its effectiveness in building the kind of trust that leads directly to new project possibilities. We also have learned the benefits of this approach can be amplified with complementary strategies that are carefully-crafted and closely-targeted, including virtual and/or in-person tours and presentations, as well as digital and/or print reports on project results.

Deliverables:

• ID target audiences for O'brien and Miller Creek – ie, people on high-priority reaches, or people whose land use practices are a source of ongoing problems

• 4 personal meetings/ phone calls/ emails with landowners that could be potential new project partners (Miller:2 mtgs; O'Brien 2 mtgs).

•Create virtual tour. Document how many times shown and to whom

State Cash Match	Local Cash Match	In-Kind Match
		$ 3,000

319 Funding Request	Total Non-Federal Match	Federal Match	Other Funding*	Total Planning Cost
$ 5,000	$ 3,000			$ 8,000

Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

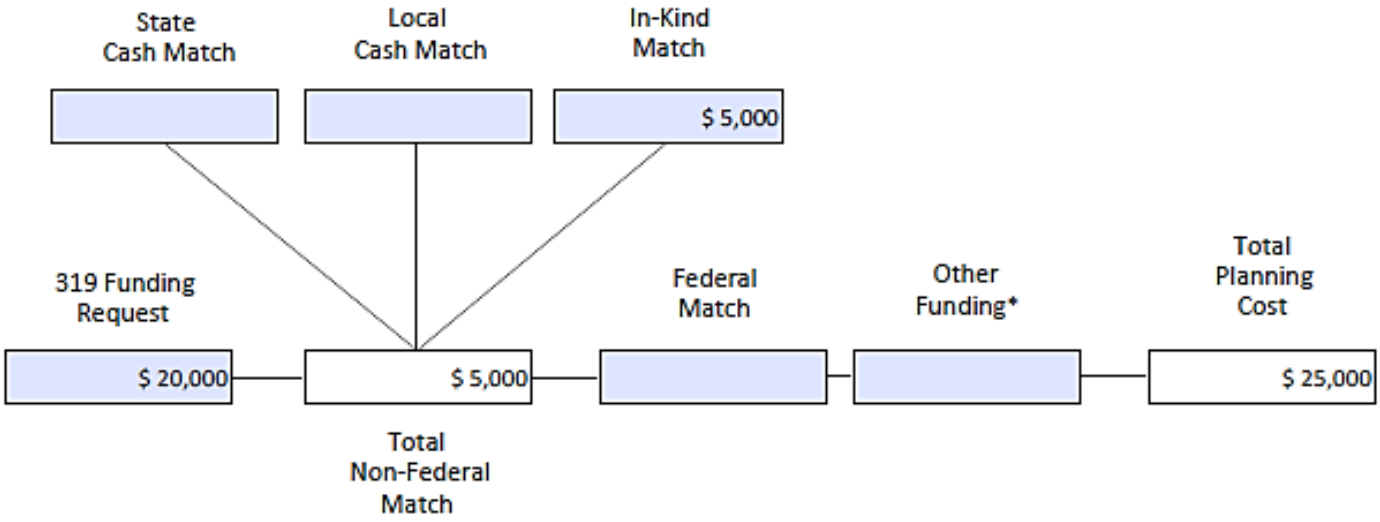
Project Administration

Project administration includes book keeping, invoicing, interim/annual/final report preparation, office supplies, rent, communications, etc. Up to 10% of the total requested 319 funds for your entire application can be used to pay for project administration. However, like all other tasks, payment is by reimbursement for actual expenses incurred.

Project Administration Deliverables *(Include interim/mid-year, annual, and final reports, as well as invoicing and office necessities.)*

Contractor shall submit to DEQ the following deliverables as described under the Project Administration Task. This includes: status reports, annual reports, Attachment B-billing statements, and a final report. Contractor shall ensure that all reports are written clearly, with appropriate grammar, punctuation, and level of detail.

Contractor will do the following with respect to all deliverables associated with all tasks in this contract:
- Adhere to report guidance and templates provided by the DEQ project manager.
- Submit all draft and final documents electronically, in Adobe PDF, Microsoft Word, or Microsoft Excel format.
- Submit all draft and final documents to the DEQ project manager using email, or if files are greater than 5.0 megabytes in size using the state of Montana file transfer service (https://transfer.mt.gov) or as directed by the DEQ project manager.



Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Form

A separate Project Form ***(including providing separate attachments)*** must be submitted for each project included in your application. Use the following examples to help determine when to lump and when to split projects. For additional assistance, contact Mark Ockey at mockey@mt.gov or 406-465-0039.

Splitting Examples (fill out multiple Project Forms)

- Stream restoration work occurring on two separate streams, on parcels owned by two separate individuals
- Two projects with significantly different sets of project partners
- Two projects that address substantially different pollution sources (e.g., one project moves a corral off of a streambank, and another removes mine tailings, with both projects being on the same property)

Lumping Examples

- Contiguous stream restoration work spanning multiple land parcels
- 3 projects that address similar sources of pollution on a single land parcel (e.g., moving a corral off a stream, implementing a grazing management plan, and relocating a manure storage facility out of the floodplain, all on the same ranch)

Project 1 Name	O'Brien Creek Meadows Restoration

Select the watershed restoration plan (WRP) that your project will help implement.

Bitterroot - Bitter Root Water Forum

N — Letter of support from author entity attached? *(If no, explain why below.)*

Because the CFC, with support of the Lolo National Forest and members of the O'Brien Creek HOA, wrote the WRP for O'Brien Creek we felt it redundant and somewhat awkward to submit a letter from the authors in support of our own proposal. We'd be happy to provide a letter from the CFC, if it would assist these efforts. We do have substantive support letters attached from other relevant stakeholders.

Waterbody name from 2020 List of Impaired Waters	Bitterroot River
Probable causes of impairment to be addressed	Temperature
Waterbody name from 2020 List of Impaired Waters	
Probable causes of impairment to be addressed	

OR*

Name of healthy waterbody to be protected	O'Brien Creek
Description of identified threat to non-impairment status	This stream has not been assessed by the DEQ yet, however, identified threats include sediment / siltation and alteration in stream-side vegetative cover
Name of healthy waterbody to be protected	Bitterroot River
Description of identified threat to non-impairment status	Recently de-listed for sediment / siltation

**While the majority of the available 319 project funding is dedicated to addressing known impairments, EPA is allowing states to use a limited amount of funding to protect non-impaired waters (healthy waters) from becoming impaired.*

Project 1 Location

Upstream End	Latitude	46.847557	Longitude	-114.118240
Downstream End	Latitude	46.849405	Longitude	-114.111744
Centerpoint	Latitude	46.848087	Longitude	-114.114415

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

List the 12-digit Hydrologic Unit Code(s) (HUCs) in which the project area is located: 170102051502

☑ Project site map(s) attached, showing the location of all proposed on-the-grount restoration activities?

Community Participation and Support

Landowner	Contributions to Project	Letter of Support Attached?
O'brien Creek Meadows HOA	Landowner, contributor to WRP and funder	☑
Hillsdales Estates POA, solely owned by Carolyn Diddel	Landowner. We have obtained a verbal go ahead for the project from Mrs. Diddel and her family but have not received a formal LOS before turning in this proposal	☐
		☐
		☐

Partner	Role	Letter of Support Attached?
Westslope Chapter of Trout Unlimited	Project supporter, volunteers and potential funds contributor	☑
Montana Fish Wildlife and Parks	Project funding through Future Fisheries program, assists with project design and monitors the fishery	☐
Missoula Valley Water Quality District	Project supporter, monitors water quality on O'brien Creek	☑
		☐

Other Community/Stakeholder Support

Project Description

Describe the nature and extent of the nonpoint source problem you are trying to address, the root causes of the problem, and your proposed solution.

The 25.4 square-mile O'Brien Creek watershed in Missoula County is an important tributary to the Bitterroot River due to it being a stronghold for native Westslope cutthroat trout. Land ownership along the creek includes public ownership on U.S. Forest Service land in the middle and headwaters reaches, and private parcels of various sizes in the lower watershed and valley bottom. The Creek has experienced extensive human uses for more than a century, including a railroad in the valley bottom for timber extraction, a grain mill at the confluence with the Bitterroot, severe manipulation from ditching and irrigation withdrawals, road development and timber harvest in the uplands, among others uses.

These land uses contributed to development of several sources of nonpoint pollution. Sediment production from eroding stream banks and upland sources produce sediment at levels high enough to smother fish spawning redds and macroinvertebrate habitat. Sediment sources include bank failures, stream entrenchment and incision, road washouts, riparian vegetation reductions, and resultant bank erosion (Bitterroot Watershed Restoration Plan, 2020)

Public and private landowners also experience ongoing issues with nonpoint sediment pollution, as found in a 2019 general longitudinal habitat assessment by Lolo National Forest. Sediment pollution is causing aggradation and frequent flooding, which also washes fertilizers and herbicides into the creek and ultimately the Bitterroot River. The residents of the O'brien Creek Meadows HOA had to file for an emergency 310 permit in 2019 due to large sediment deposits in their reach causing the creek to jump its banks and flood a large area of their common area and a county roadway. In several areas, roads encroach the stream or flood-prone areas, leading to chronic delivery of sediment from roadbeds, active erosion of road fills into the stream, and at least one serious bank failure that needs immediate remediation. This has created a safety risk of cars sliding into the creek, especially in winter). The county road that is directly adjacent to the stream for several stretches is likely adding toxic chemicals from oil and tires as well. An undersized culvert on another county road in the project area has led to water backing up and increased erosion and sediment deposition.

The Clark Fork Coalition proposes to address NPS issues on O'Brien Creek by working with the O'brien Creek Meadows HOA and the upstream landowner to restore a 2,500 ft reach of O'brien Creek. The project will reduce sediment loading, restore stream and floodplain function,, improve riparian and instream wildlife habitat, and dissipate flood energy.

The project is focused on a 2,500-foot section of the creek immediately upstream of Tripple Creek Road that experienced a massive bank failure in 2019 which led to deposition and instability in the creek's lower reaches. The O'Brien Creek Home Owners Association approached the Clark Fork Coalition to assist with bank erosion, stream incision, aggradation and avulsion problems in this reach.

The following treatments are proposed on approximately 2,500 feet of O'Brien Creek:

- Channel Reshaping and Realignment
- Floodplain reconnection
- Large wood installation
- Riparian planting

Is this project a continuation of a previous project? If so, please explain the connection.

Yes; The Clark Fork Coalition has been actively working to restore O'brien Creek for over 17 years now starting with an instream flow lease to reconnect the dewatered lower reaches of the creek in 2004. In 2014 CFC permanently acquired 3.6 cfs of water and entered a 10 year lease for an additional 1.2 cfs. These water rights protect all the available water in the creek from it's headwaters to the confluence with the Bitterroot during the critical low flow months of July, August and September. Building on these water rights and protecting the water quality and aquatic habitat of the creek has been a long term goal of CFC. In addition to CFC's work in the watershed the Lolo NF has completed large scale road decomissioning in the headwaters to reduce sediment and facilitate fish passage. This was coupled with MT FWP upgrading the crossing at Blue Mountain Rd and completing a channel restoration on the lowest 700 feet of the creek.

Water Quality Benefits and Sustainability

Explain why the project is an appropriate next step for making progress towards removing a pollutant/waterbody combination from Montana's 2020 Impaired Waters List or preventing a healthy waterbody from becoming impaired?

In 2019 CFC teamed up with the Lolo National Forest on an in-depth assessment of the creek's ecological health and updating the Bitterroot WRP. From the results of the assessment it became clear that there are miles of O'Brien Creek that are incised with eroding banks that are adding to an excess sediment load. The O'Brien Creek Meadows reach became our top priority after a massive bank failure in that reach led to the HOA receiving an emergency 310 permit to deal with subsequent flooding. In 2020 CFC was awarded a 319 grant to complete a restoration design for the O'brien Creek Meadows project and in 2021 CFC was awarded a 319 WMG with the goal of developing additional projects on the creek that would target sediment sources.

Will your project address a major local source of nonpoint source pollution? Explain.

Yes; The 2019 Forest Service assessment, which covered O'brien Creek from its confluence with the Bitterroot River to the headwaters, found that O'Brien Creek is adding large amounts of sediment to the Lower Bitterroot River, where millions of dollars have already been invested to protect from nonpoint source pollution. The O'Brien Creek Meadows reach was identified as one of the reaches adding large amounts of sediment load to the stream due to numerous eroding banks including a massive 20ft+ cut bank and a priority for restoration.

Will the project create long-term, sustainable reductions in NPS pollution? Explain.

Yes; Our proposed treatments will eliminate root causes of NPS pollution in the project reach by moving the stream away from the road, adding a 24" flood relief culvert at Trippel Creek road crossing, and stabilizing eroding streambanks by laying them back and revegetating them. We will also treat the current issues with incision by moving the stream into existing historic channels and creating new channel in order to reconnect the creek with its floodplains.

Describe how the project will promote self-maintaining, natural, ecological and social processes that protect water quality?

The goal of this project is to restore natural processes to O'Brien Creek. Much of the creek's sediment issues originated from unnatural processes, such as historical residents straightening the creek to increase agricultural production, water for irrigation, and provide railroad access for timber extraction. Our proposed treatments will help return the creek to a more natural state by re-connecting the floodplain in entrenched segments, reshaping and re-aligning to the stream to dimensions, pattern, and a gradient that conforms to the current climate and valley setting, and replacing removed wood for energy dissipation and recovery of fisheries habitat.

Nonpoint Source Goals and Success Metrics

Nonpoint source pollution goal	Action that will be taken to reach the goal	Metrics used to measure success
O'Brien Creek: - Reduce tons / yr of sediment generated by interaction with parallel road segments	-Reduce road-stream channel interactions through channel re-location -Stabilize road fillslope failures to reduce sediment inputs to the channel.	Reductions in tons/yr of sediment measured through WEPP modeling. Success of re-vegetation measured through photo-points.
O'Brien Creek: -Reduce tons / yr sediment delivery from stream bank erosion (currently 1-2 orders of magnitude above natural levels - From Bitterroot WRP).	-Treat streambank erosion to reduce sediment inputs to the channel. -Increase sediment storage, the frequency of pools, and aquatic habitat complexuty with wood installation -Reconnect former floodplain surfaces by slightly raising the channel profile	Reductions in tons/yr of sediment measured through BEHI surveys. Increased number of instream wood and pools Success of re-vegetation measured through photo-points.

Project Education and Outreach

Describe the educational benefits of your project. Will the project inspire additional nonpoint source pollution prevention work within the watershed?

Seeing is believing. These projects boost the ecological health of familiar, backyard streams, curb land loss for local property owners, and reduce maintenance costs. Those are real benefits that get to the heart of what landowners care about. At the same time these projects provide a tangible, visible examples of neighbor helping neighbor; of the kind of services CFC can provide to landowners; and the power of collaboration when private landowners, NGOs, and natural resource agencies work together. We've seen this work as a way to attract new landowners to pursue new projects in the past, and we believe that will be the case here too, especially when accompanied by personal outreach, tours, reports, and media stories. Specifically we plan to reach out to landowners and HOA's on the creek that own reaches prioritized for restoration through phone calls, virtual and in person tours of the finished project reach.

Bigger Picture Benefits

NPS pollution projects often have benefits that go beyond simply cleaning up Montana's lakes and streams. Describe your project's benefits to each of the items below. If there are no associated benefits, type "NA" for "not applicable".

Environmental Justice (EJ)

Will the project improve or create public access to a healthy environment?

O'Brien Creek flows into the Bitterroot River within one mile of the confluence with the Clark Fork River. O'Brien Creek is relatively cold, and as such, is a priority fishery, despite a long history of detrimental impacts. By reducing the source of sediment to the creek and improving stream conditions, this project, coupled with potential future projects, can provide substantive improvements to the overall health of both the Bitterroot and Clark Fork River fishery, stream conditions, and water quality.

Will the project have a public benefit in a county where 15% or more of the population lives below the poverty level? Counties include: Big Horn, Blaine, Chouteau, Deer Lodge, Garfield, Glacier, Golden Valley, Hill, Lake, Liberty, Lincoln, Meagher, Mineral, Musselshell, Pondera, Powell, Roosevelt, Rosebud, Sanders, Silver Bow, Toole and Wheatland.

No, project is located in Missoula County

Will the project benefit historically underserved populations (e.g. minority populations, people with disabilities)?

No; we cannot make a direct connection for this project benefiting historically underserved populations

Climate Change

Will the project improve climate change resilience for communities, native plants, wildlife or ecosystems?

Yes, this project will increase climate change resiliency and adaptation in a few different ways. By allowing the creek to access its floodplain, adding woody debris, and enhancing riparian vegetation, there is opportunity for increased groundwater and surface water storage, which is important as Montana's summers get hotter and drier. The enhanced riparian vegetation will also act as shade to prevent water temperatures from increasing during drought and low-water years. Stream runoff is predicted to become flashier and more extreme - our proposal affords greater channel resiliency towards fluctuations in both flooding and drought conditions.

Will the project restore or protect cool, late-season flow?

Yes; The project will lead to more connectivity to the floodplains, a proven method for recharging ground water and contributing to late season flows.

Impacts to Downstream Communities

Will the project reduce pollutant loading above a permitted point source discharge in a way that could increase assimilative capacity in the the receiving water?

This project will reduce sediment pollution loading, however, there are not any known permitted point source discharges downstream.

Will the project help protect a drinking water source?

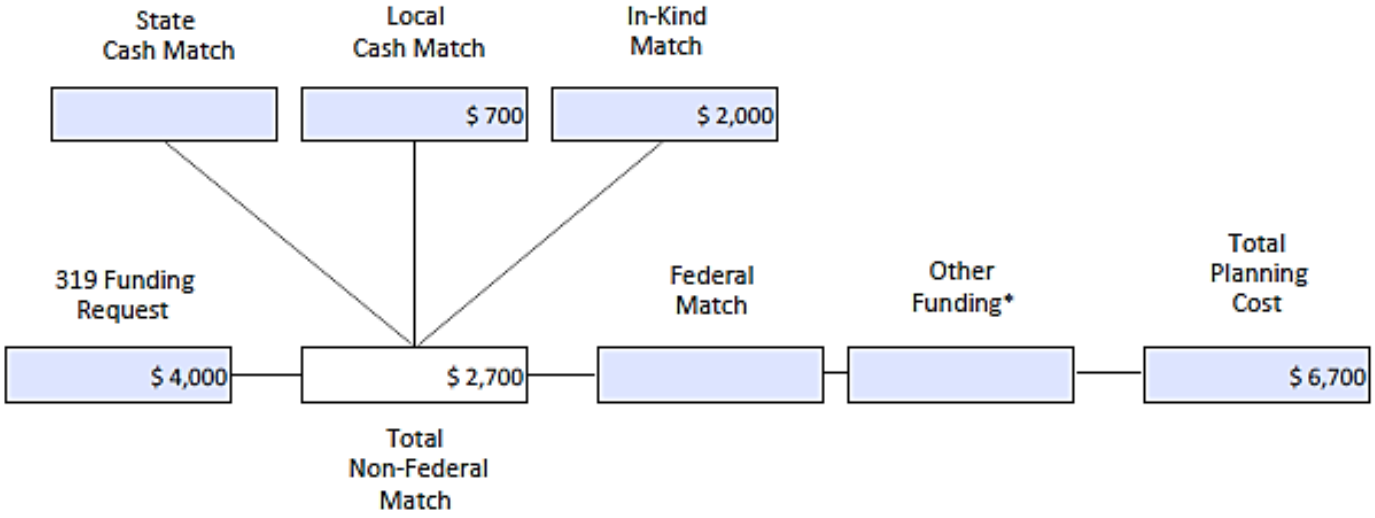
No; This project does not involve protecting drinking water.

Tasks and Budget

DEQ uses a standard template to develop scopes of work for 319 contracts. The tasks below match up with DEQ standard scope of work template. Some tasks might not be applicable to your project. Please leave the non-applicable tasks blank. If your project doesn't fit the task outline, use the task labeled "Other" to describe your project.

Task 1 - Project Planning Deliverables *(Include such things as completing project designs, conducting site evaluations, obtaining permits, organizing volunteers, conducting scoping meetings, etc. Identify specific deliverables that will be submitted.)*

Most project planning activities have been completed for this project under a previous 319 grant. Items left to complete under this task are: permitting and organizing volunteers.
Contractor shall submit to DEQ the following deliverables:
- Volunteer sign in sheets
- A list of all permits and authorizations necessary for implementation.
- Documentation of the landowners' acceptance and approval of the final designs.



Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

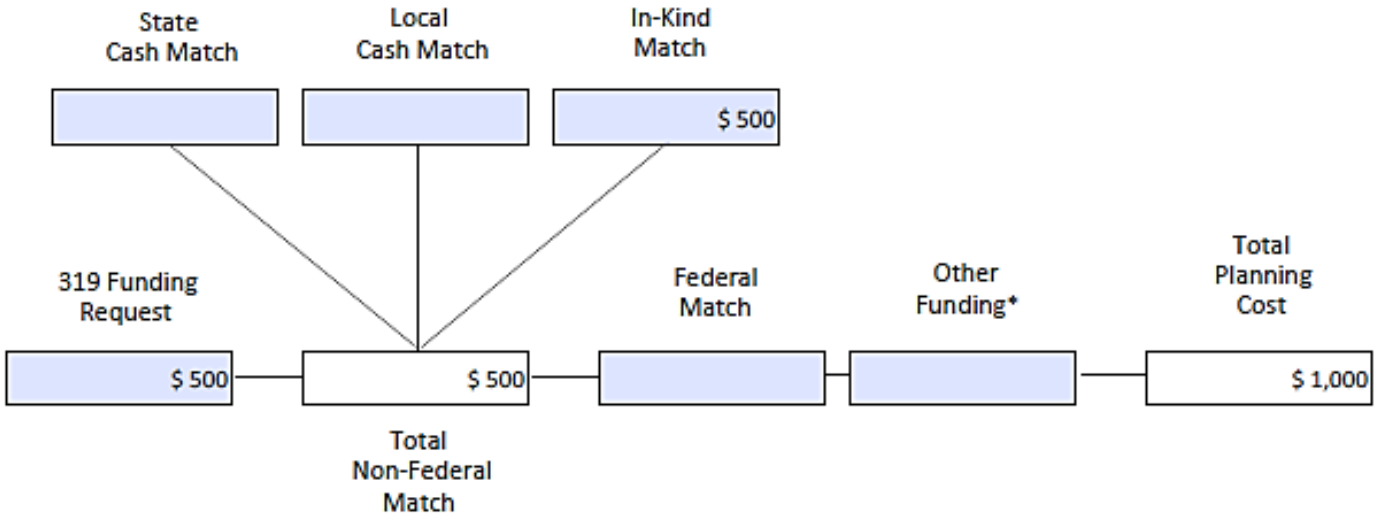
**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Landowner Agreements, Operation and Maintenance

This task only applies to projects involving on-the-ground activities. DEQ periodically evaluates the effectiveness of each on-the-ground project. To accomplish this, DEQ requires a process be in place to allow periodic access to the project site. The landowner agreement should also specify the roles of each project partner in the design, implementation and continued operation of on-the-ground pollution prevention practices. DEQ does not require the use of a specific landowner agreement template. In some situations, existing agreements between the project sponsor and the landowner may be sufficient.

Task 2 - Landowner Agreements, Operation and Maintenance Deliverables *(Include such things as landowner/ sponsor communication, and draft and final agreements.*

CFC has already obtained a signed agreement (using a DEQ template) from the O'Brien Creek Meadows HOA but while having a very positive verbal response from Hillsdale Estates we still need to obtain a signed LOA.
Contractor will submit to DEQ the following deliverables:
• Draft landowner agreements for review and comment, in Microsoft Word or pdf format. Contractor will submit all draft landowner agreements prior to signature, and allow sufficient time for review, comment, and subsequent modification prior to implementation.
• PDF copies of signed landowner agreements. Contractor will ensure signed landowner agreements address all comments and concerns raised by DEQ.



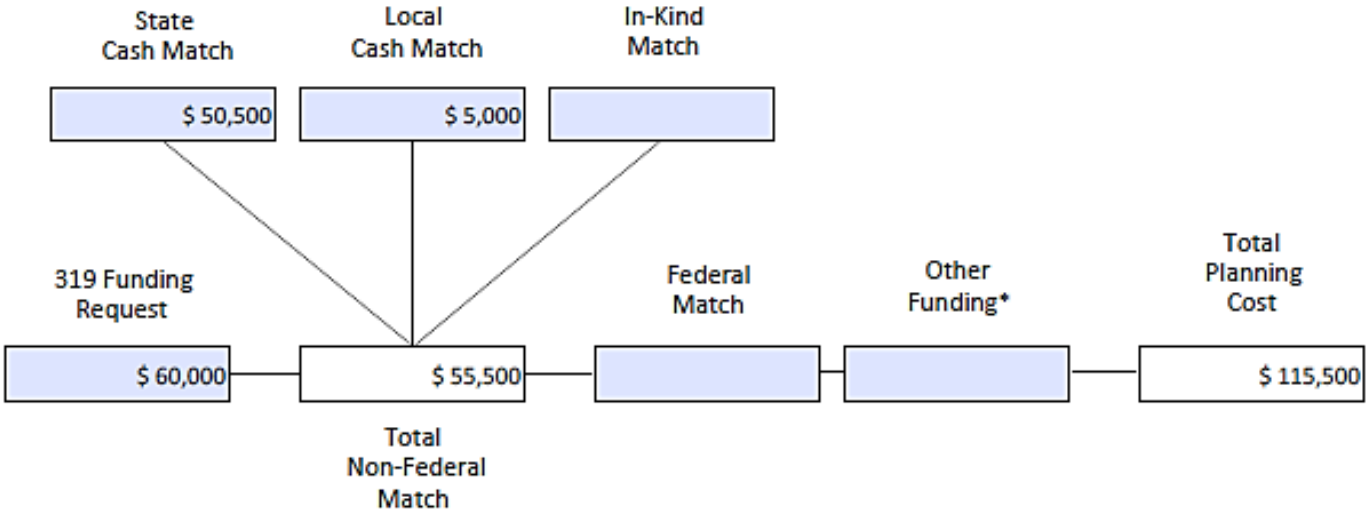
Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Implementation

Task 3 - Project Implementation Deliverables *(Include such things as construction oversight, implementation of on-the-ground restoration practices, preparation and submittal of as-built drawings, etc.)*

• Draft request for proposals (RFP) for DEQ review and comment (for implementation). Contractor shall submit draft RFP prior to release and allow at least 30 days for DEQ review, comment, and subsequent modification prior to release
• A final copy of the RFP
• Implementation of on-the-ground restoration including channel relocation, bank and roadside stabilization, possibly moving road, wood installation, and possible floodplain reconnection.
• A detailed description of any deviations from the final project map completed under project implementation task and an explanation for the need for each deviation.



Match Source	FWP Future Fisheries	Secured	
Match Source	DNRC RRG	Secured	
Match Source	Westslope Chapter Trout Unlimited	Secured	
Match Source	O'Brien Creek Meadows HOA	Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Other Activities

Use this task if the activities you are proposing are outside the scope of the typical design/implement/monitor process. Provide sufficient details to enable application reviewers to successfully compare the nonpoint source pollution reduction benefits of your project to those of other projects in the applicant pool.

Task 4 - Project Deliverables *(Include activities you will complete and the products you will submit to demonstrate completion.)*

State Cash Match	Local Cash Match	In-Kind Match

319 Funding Request		Federal Match	Other Funding*	Total Planning Cost
	$ 0			$ 0
	Total Non-Federal Match			

Match Source		Secured	
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Effectiveness Monitoring

The short duration (1-3 years) and limited spatial extent (often just a few hundred yards) of most 319-funded projects frequently precludes the use of traditional water chemistry monitoring as a means of evaluating project effectiveness. Instead, DEQ encourages project sponsors to use simpler, more qualitative tools. Typically, this will include pre- and post-construction photo point monitoring, vegetation mortality measurements, and perhaps modeling to estimate pollution load reductions. Please contact one of the DEQ Nonpoint Source Program staff for guidance relative to your specific project.

Task 5 - Project Effectiveness Monitoring Deliverables *(Identify the specific tools and products you will use to evaluate and demonstrate the effectiveness of your project in reducing nonpoint source pollution.)*

Contractor shall submit to DEQ the following deliverables:
• A complete draft monitoring plan for review and comment in electronic (Microsoft Word) format, allowing sufficient time for review, comment, and subsequent modification prior to implementation. The monitoring plan must identify the specific monitoring that will occur, who will complete the monitoring, and how the data will be analyzed and reported.
• A final monitoring plan. Contractor shall ensure that the final monitoring plan addresses all comments and concerns raised by DEQ.
• A written summary of all monitoring activities. The written summary must include the following:
o Electronic copies of photo-point photographs, in JPEG format. A photo log identifying photo ID, site ID, photo date, photographer name, latitude and longitude from which the photo was taken, approximate direction the photographer was facing, and a brief description of what the photo is intended to show.
o Electronic copies of all data and data analyses.
o A detailed description of any deviations from the final monitoring plan, and an explanation of the need for each deviation.
o An estimate of sediment load reductions, in tons/year, achieved through implementing on-the-ground projects.

State Cash Match	Local Cash Match	In-Kind Match	319 Funding Request	Federal Match	Other Funding*	Total Planning Cost
		$ 2,000	$ 4,000			$ 6,000

Total Non-Federal Match: $ 2,000

Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Additional Attachments

Attach additional items that could help reviewers better understand your project. Items could include site photos, design drawings, site evaluations, permits, etc. Please be conscious of reviewers' time, as they may not have time to read lengthy studies and reports. List all additional attachments below.

- [x] Project Design
- [x] Construction Cost Estimate
- [x] Pre-Project Photos
- [x] O'Brien Creek Meadows LOA
- [ ]
- [ ]

Additional information that could assist reviewers in evaluating the project's potential impact on NPS pollution.

This project, and the other two we are proposing for the 2022 round of 319 funding, are the direct result of investments made by the DEQ 319 to prioritize projects that reduce NPS pollution in the Bitterroot. CFC rose to the challenge in 2019 when DEQ announced that they would be focusing funding on the Bitterroot for the next 3 years and since then has shifted the focus of two of their project managers to Bitterroot NPS pollution projects and hired a third project manager who is entirely focused on restoring the tributaries of the lower Bitterroot River. CFC has utilized DEQ 319 watershed planning grants in both O'Brien and Miller Creek and E&O funding to develop and prioritize the 3 projects we are bringing forward for 2022.

Letters Of Support

O'Brien Creek Meadow HOA, INC
PO Box 3502
Missoula, MT 59806-3502

O'Brien Creek Meadow HOA, Inc.
PO Box 3502
MT 59806-3502

October 29, 2019

Department of Environmental Quality – 319 Program
P.O. Box 200901
Helena, MT 59620-0901

To Whom It May Concern:

Please accept this letter as the O'Brien Creek Meadow HOA's endorsement of the proposed rehabilitation work for the segment of O'Brien Creek that flows through our common area. We understand that the Clark Fork Coalition is working on our behalf to assist with funding support for necessary rehabilitation that will fulfill both our 310 stream permit requirements and contribute to the overall watershed restoration planning efforts.

We have learned a lot about O'Brien Creek since our segment of stream jumped its banks this year (and two years prior). We have a diverse group of landowners that largely are genuinely interested in helping to improve stream conditions, and as importantly, we realize that stream maintenance and associated costs will return until the stream is functioning better. The process of grant writing and all the parties involved to make projects happen is very complex, and we welcome the assistance from the Clark Fork Coalition. We also have several landowners that have helped with the stream work this year, and we plan to provide additional assistance as we have the expertise, time, resources, and majority support.

We are just learning of the Montana Department of Environmental Quality's role in managing streams to improve water quality and perform watershed restoration planning and funding. We greatly appreciate your support of this important proposal. As we've also come to understand, funding support is very limited, making funding from your 319 Program critical to our success. To help ourselves and our mutual success, we want to hire very experienced stream professionals and will do all that we can to produce a very high quality product. With this in mind, we hope that restoration work on our property may also provide the state and local agencies with an example that can be used on other work in O'Brien Creek and perhaps other watersheds. Thank you for your consideration.

Sincerely,

Michael Burks
President
O'Brien Creek Meadow Home Owners Association, Inc

WestSlope Chapter
Trout Unlimited
Missoula, Montana

October 28, 2021

To Whom it may concern,

The WestSlope Chapter of Trout Unlimited (WSCTU) works to preserve, protect and restore cold water fisheries in the Missoula area. Collectively, the chapter represents over 900 passionate anglers that care deeply about our mission. We write to express our support for three different projects being proposed by the Clark Fork Coalition on tributaries of the lower Bitterroot River:

- **O'brien Creek Meadows Stream Restoration:** This project aims to use a variety of treatments to reduce sediment loading, restore stream and floodplain function, improve riparian and in-stream wildlife habitat, and dissipate flood energy on a 2500 foot section of O'brien Creek.

- **Upper O'Brien Creek Stream Restoration:** This project proposes to address non-point sediment issues and fish habitat on upper O'Brien Creek by working with the Forest Service to reduce sediment loading, restore stream and floodplain function, and improve in-stream wildlife habitat. The project is focused on a 1.5 mile section of the creek where the stream is entrenched, has little in-stream wood, and is encroaching into road fills.

- **Miller Creek Mile 7 Project:** This project proposes to address sedimentation issues and degraded habitat on a section of Miller Creek. Treatments such as floodplain grading, woody debris matrix, riparian shrub plantings with enclosure fences, a hardened crossing for livestock, and other treatments to re-connect the creek to its floodplain, slow and disperse high flows, and increase riparian habitat will be used.

Given the benefits these projects will have for cold-water fisheries and watershed health, WSCTU supports their implementation. Thank you for the opportunity to comment.

Sincerely,

Mark Kuipers President

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

Project Map

O'BRIEN CREEK RESTORATION PROJECT
PRELIMINARY DESIGN PLAN SET

PROJECT PARTNERS

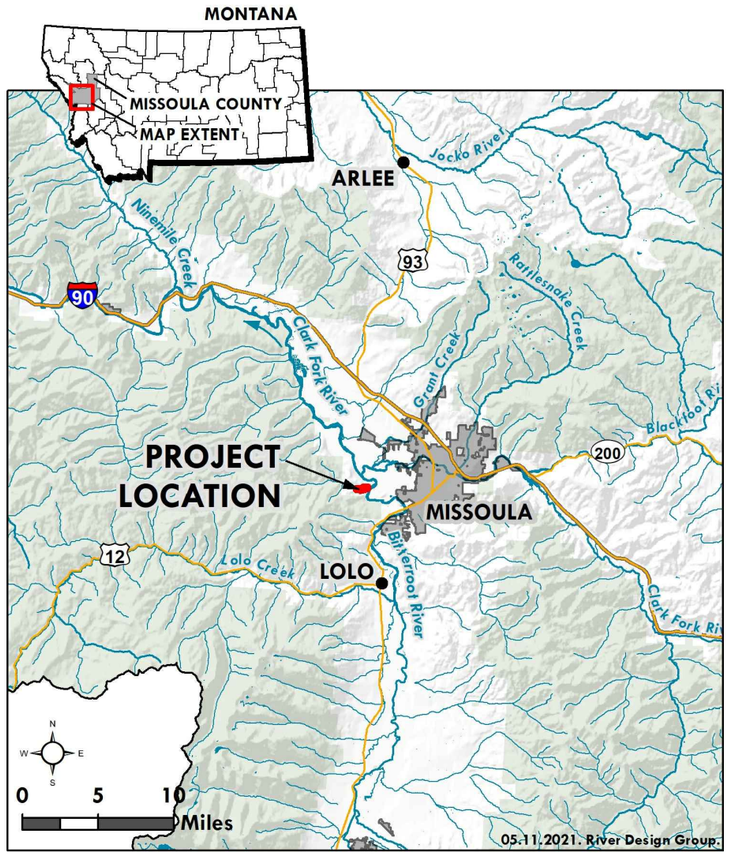
CLARKFORK COALITION
140 S 4TH STREET WEST #1
MISSOULA, MONTANA 59801

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
1520 E 6TH AVENUE
HELENA, MONTANA 59601

HILLSDALE ESTATES PROPERTY MANAGERS ASSOCIATION

O'BRIEN CREEK MEADOWS HOMEOWNERS ASSOCIATION

O'BRIEN CREEK VICINITY MAP



LEGAL DESCRIPTION: NW $\frac{1}{4}$ S34,T13N, R20W; AND SE$\frac{1}{4}$ S27, T13N, R20W
MISSOULA COUNTY, MONTANA

PROJECT DESCRIPTION

CLARK FORK COALITION, IN PARTNERSHIP WITH MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, HAS RETAINED RIVER DESIGN GROUP, INC. TO DEVELOP A PRELIMINARY RESTORATION DESIGN FOR A 0.3-MILE REACH OF LOWER O'BRIEN CREEK, A TRIBUTARY TO THE BITTERROOT RIVER NEAR MISSOULA, MONTANA. THE DRAWINGS CONTAINED IN THIS PLAN SET REPRESENT A 65% DESIGN LEVEL EQUIVALENT AND WILL BE REFINED AND FINALIZED FOLLOWING INPUT FROM PROJECT STAKEHOLDERS.

DRAWING INDEX

GENERAL NOTES

1. CONTOUR INTERVAL IS NOTED ON DRAWINGS.
2. SLOPES DESIGNATED AS 2:1, 1.5:1, ET CETERA, ARE THE RATIOS OF HORIZONTAL DISTANCE TO VERTICAL DISTANCE.
3. DIMENSIONS ARE GIVEN IN FEET AND TENTHS OF A FOOT.
4. SURVEY DATA WAS COLLECTED UTILIZING SURVEY GRADE GPS IN SEPTEMBER 2021. FIELD DATA SUPPLEMENTED LIDAR DATA COLLECTED IN SPRING, 2019 TO COMPLETE THE EXISTING GROUND SURFACE. ALL SURVEY DATA WAS COORDINATED BY RDG.
5. ALL EXISTING CONDITIONS ARE TO BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION AND ANY ADJUSTMENTS TO THE DRAWINGS SHALL BE MADE AS DIRECTED BY THE ENGINEER.
6. EXISTING PRIVATE IMPROVEMENTS, WHICH LIE WITHIN THE CONSTRUCTION LIMITS, UNLESS OTHERWISE NOTED WILL BE REMOVED BY THE OWNER PRIOR TO CONSTRUCTION, OR ABANDONED IN PLACE.
7. PROTECT ALL TREES AND LAND AREAS NOT LOCATED WITHIN THE PROJECT CONSTRUCTION, STAGING OR EARTHWORK LIMITS. EXERCISE CARE IN AREAS NOT SO MARKED TO AVOID UNNECESSARY DAMAGE TO NATURAL VEGETATION.
8. THE PROJECT SPONSOR IS RESPONSIBLE FOR COMPLYING WITH ALL PERMITS AND EASEMENTS INCLUDING ALL FEDERAL, STATE, COUNTY, AND LOCAL PERMIT CONDITIONS.
9. EXCAVATION, TRENCHING, SHORING, AND SHIELDING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR PERFORMING THE WORK, THESE DRAWINGS ARE NOT INTENDED TO PROVIDE MEANS OR METHODS OF CONSTRUCTION.
10. EXCAVATION SHALL MEET THE REQUIREMENTS OF OSHA 29 CFR PART 1926, SUBPART P, EXCAVATIONS. ACTUAL SLOPES SHALL NOT EXCEED THE SLOPES AS INDICATED ON DRAWINGS.
11. AT LEAST ONE EXCAVATOR SHALL BE EQUIPPED WITH MACHINE GRADE GPS ((L1/L2/GLONASS)). CONSTRUCTION AREAS WILL BE STAKED OUT PRIOR TO CONSTRUCTION USING SURVEY GRADE GPS (L1/L2/GLONASS).
12. ENGINEER WILL PROVIDE SURVEY CONTROL AND GRADING SURFACES FOR EQUIPMENT WITH GPS MACHINE CONTROL CAPABILITY. CONTRACTOR SHALL PROVIDE SURVEY STAKING AND LAYOUT FOR CONSTRUCTION.
13. VERTICAL TOLERANCE FOR CONSTRUCTION COMPLIANCE WILL BE 0.3 FEET. HORIZONTAL TOLERANCE WILL BE 1.0 FEET.
14. CONTRACTOR SHALL CONFIRM QUANTITIES. REPORTED VOLUMES ARE NEATLINE AND DO NOT INCLUDE ADJUSTMENTS FOR COMPACTION OR OTHER FACTORS.

STANDARD OF PRACTICE

RIVER DESIGN GROUP, INC. WORKS EXCLUSIVELY IN THE RIVER ENVIRONMENT AND UTILIZES THE MOST CURRENT AND ACCEPTED PRACTICES AVAILABLE FOR PLANNING AND DESIGN OF RIVER, FLOODPLAIN, AND AQUATIC HABITAT RESTORATION PROJECTS. CURRENT STANDARDS FOR THE DESIGN OF RESTORATION PROJECTS VARY DEPENDING ON PROJECT GOALS. STABILITY CRITERIA INCLUDE DESIGNING STREAMBED AND STREAMBANK STRUCTURES FOR THE 25-YR RECURRENCE INTERVAL DISCHARGE FLOOD. REGIONAL CURVES WERE USED TO EVALUATE BANKFULL DISCHARGE, AND HIGHER RETURN INTERVAL DISCHARGES INCLUDING THE 100-YEAR FLOW.

REUSE OF DRAWINGS

RDG RIVER DESIGN GROUP
236 Wisconsin Avenue 311 SW Jefferson Avenue
Whitefish, MT 59937 Corvallis, OR 97333
406.862.4927 541.738.2920

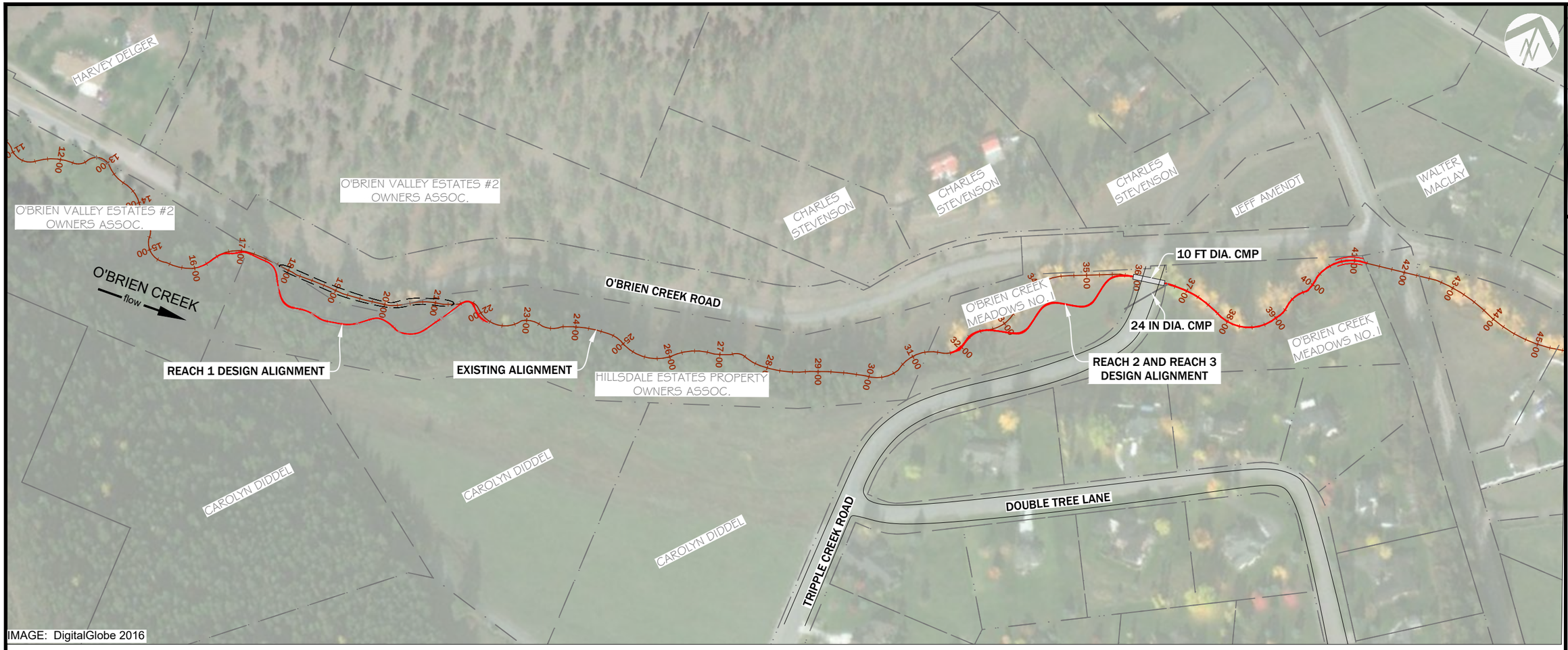
COVER PAGE AND NOTES
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
1.0

Drawing .0 of 16



1 OBRIEN CREEK PLAN VIEW

1" = 200'

O'BRIEN CREEK WATERSHED DESCRIPTION

THE O'BRIEN CREEK WATERSHED ENCOMPASSES 25.4 SQUARE MILES AND IS A MAJOR TRIBUTARY TO THE BITTERROOT RIVER UPSTREAM OF THE CONFLUENCE WITH THE CLARK FORK RIVER. ONE OF THE MOST IMPORTANT TRIBUTARIES IN THE LOWER BITTERROOT RIVER FOR RAINBOW AND CUTTHROAT TROUT (MT FWP, 2019), LAND OWNERSHIP IN THE WATERSHED IS A MIX OF US FOREST SERVICE AND PRIVATE OWNERSHIP. SIMILAR TO MOST FORESTED WATERSHEDS IN THE REGION, O'BRIEN CREEK HAS EXPERIENCED HUMAN-CAUSED IMPACTS FROM FORESTRY, GRAZING, MILL OPERATIONS, DEWATERING, CHANNELIZATION, AND DEVELOPMENT. IN THE LOWER WATERSHED, WATER MANIPULATION AND WITHDRAWALS CREATED FLOW INTERMITTENCY AND CHANNEL DEWATERING. RECENT EFFORTS TO BRING AWARENESS TO THIS ISSUE, AND SENIOR WATER RIGHT PURCHASES, HAS RETURNED PERENNIAL OR YEAR-ROUND FLOW TO ALL REACHES OF O'BRIEN CREEK.

PROJECT BACKGROUND

STREAM INVENTORIES COMPLETED BY THE US FOREST SERVICE IN 2019 IDENTIFIED OPPORTUNITIES TO IMPROVE AQUATIC HABITAT AND STREAM CHANNEL CONDITIONS THROUGHOUT THE O'BRIEN CREEK WATERSHED (USFS, 2019). THESE EFFORTS WERE UNDERTAKEN, IN PART, TO SUPPORT TMDL SEDIMENT LOAD REDUCTION TARGETS FOR THE BITTERROOT RIVER, WHICH HAS BEEN IDENTIFIED AS AN IMPAIRED WATERBODY BY THE MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY. EPISODIC MASS FAILURE EVENTS HAVE OCCURRED IN THE O'BRIEN CREEK WATERSHED, INCLUDING A MASSIVE BANK FAILURE IN 2019 THAT RESULTED IN LARGE-SCALE CHANNEL DEPOSITIONS AND INSTABILITY IN THE LOWER REACHES OF O'BRIEN CREEK UPSTREAM OF TRIPPLE CREEK ROAD. AFTER THE BANK FAILURE, THE O'BRIEN CREEK MEADOW HOMEOWNER'S ASSOCIATION WAS GRANTED A TWO-PHASE 310 PERMIT BY MISSOULA CONSERVATION DISTRICT TO CONDUCT EMERGENCY ACTIONS TO REMOVE THE SUBSTRATE DEPOSITION. PHASE 1 WORK WAS COMPLETED IN 2019 AND INVOLVED REMOVING SUBSTRATE DEPOSITION AND RETURNING WOOD TO THE CHANNEL.

RIVER DESIGN GROUP, INC. WAS RETAINED BY CLARK FORK COALITION, IN PARTNERSHIP WITH PRIVATE LANDOWNERS AND MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, TO PREPARE RESTORATION PLANS FOR IMPLEMENTATION OF PHASE 2 WORK WHICH HAS NOT BEEN COMPLETED AND WILL INVOLVE REHABILITATING THE CHANNEL TO IMPROVE STREAM FUNCTION AND REDUCE OR ALTOGETHER ELIMINATE THE NEED FOR FUTURE MAINTENANCE. CONCEPTUAL RESTORATION PLAN DRAWINGS INCLUDED IN THIS PLAN SET ILLUSTRATE THE PREFERRED RESTORATION ALTERNATIVE FOR THE SITE, WHICH INCLUDES RESTORING CONDITIONS THAT SUPPORT THE RECOVERY OF RIVER, FLOODPLAIN, AND AQUATIC HABITAT CONDITIONS.

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

EXISTING CONDITIONS

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

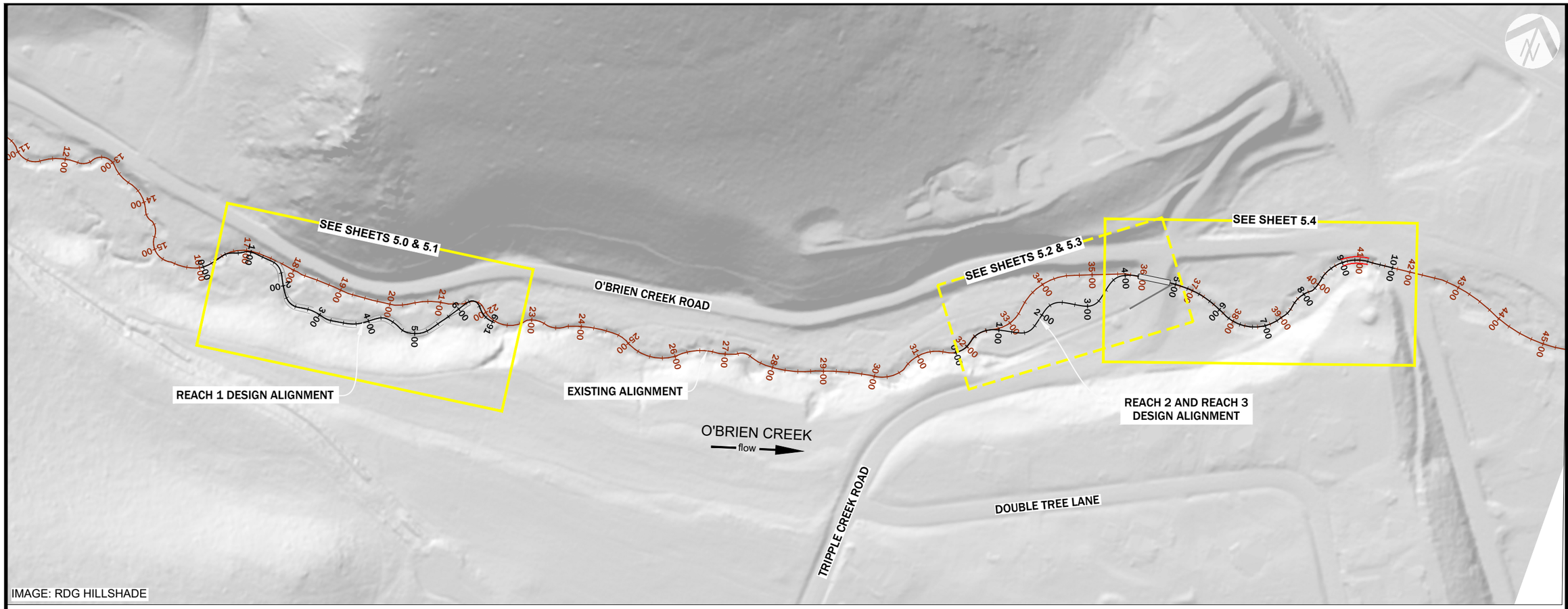
NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
2.0

Drawing .0 of 16

\\rdgfs\Projects\2021\RDG-21-169 O'Brien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg



1 OBRIEN CREEK PLAN VIEW

1" = 200'

RESTORATION GOALS

THE O'BRIEN CREEK PRELIMINARY RESTORATION DESIGN ADDRESSES LIMITING FACTORS IDENTIFIED BY PROJECT STAKEHOLDER BASED ON PREVIOUS STUDIES AND INVESTIGATIONS. THE PRIMARY GOALS OF THE PROJECT ARE TO RESTORE CHANNEL AND FLOODPLAIN CONDITIONS THAT SUPPORT HIGH QUALITY AQUATIC HABITAT CONDITIONS, PROMOTE THE ESTABLISHMENT OF A DIVERSE RIPARIAN FLOODPLAIN CORRIDOR THAT IS HYDROLOGICALLY CONNECTED TO THE CHANNEL, AND IMPROVE WATER QUALITY TO SUPPORT DOWNSTREAM BENEFICIAL USES. SPECIFIC GOALS FOR THIS PROJECT INCLUDE:

- REDUCE SEDIMENT LOADING TO O'BRIEN CREEK BY: 1) REALIGNING O'BRIEN CREEK THROUGH HISTORICAL MEANDER SCROLLS IN ORDER TO ISOLATE THE CHANNEL FROM CHRONIC SOURCES OF SEDIMENT ASSOCIATED WITH O'BRIEN CREEK ROAD; AND 2) ISOLATING O'BRIEN CREEK FROM ROTATIONAL SLOPE FAILURES THROUGH FLOODPLAIN CONSTRUCTION.
- CONSTRUCTING A NEW MODERATELY ENTRENCHED, RIFFLE-POOL, B3 STREAM TYPE WITHIN A TERRACED VALLEY, CONNECTED TO A BROAD AND WELL-VEGETATED BANKFULL FLOODPLAIN.
- IMPLEMENTING STREAMBANK, FLOODPLAIN, AND RIPARIAN REVEGETATION TECHNIQUES TO INCREASE THE COVER OF WOODY RIPARIAN SHRUBS AND TREES.
- REDUCING FLOOD HAZARD RISK TO PRIVATE PROPERTY BY CREATING A FUNCTIONAL, INSET FLOODPLAIN THAT IS CONNECTED TO THE CHANNEL AND WILL PROVIDE FLOOD ENERGY DISSIPATION.

RESTORATION TREATMENTS

RESTORATION WILL OCCUR ALONG 0.3 MILES OF O'BRIEN CREEK AND WILL BE COMPLETED IN THE DRY DURING FALL 2022. IMPLEMENTATION WILL BE CLOSELY INTEGRATED WITH CLARK FORK COALITION, MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, PRIVATE LANDOWNERS, AND STAKEHOLDERS. IN REACH 1, O'BRIEN CREEK IS CHANNELIZED AND IS BRACKETED AGAINST THE O'BRIEN CREEK ROAD FILLSLOPE, A CHRONIC SOURCE OF SEDIMENT AND OTHER POLLUTANTS TO O'BRIEN CREEK. IN THIS REACH, THE CHANNEL WILL BE RELOCATED TO THE SOUTH THROUGH HISTORICAL CHANNEL SCROLLS AND RECONNECTED WITH WELL VEGETATED FLOODPLAIN SURFACES, INCREASING STREAM LENGTH BY 20%.

IN REACH 2, A NEW CHANNEL WILL BE CONSTRUCTED TO ADDRESS EXISTING IMPAIRMENTS INCLUDING DEGRADED HABITAT CONDITIONS, HIGH SEDIMENT LOADING FROM BANK EROSION, AND DECREASED SEDIMENT TRANSPORT CAPACITY. A MODERATELY ENTRENCHED, COBBLE DOMINATED, RIFFLE-POOL B3 STREAM TYPE WILL BE CONSTRUCTED WITHIN A BROAD, WELL VEGETATED FLOODPLAIN CORRIDOR. A VARIETY OF STREAMBED, STREAMBANK, FLOODPLAIN AND REVEGETATION TREATMENTS WILL BE IMPLEMENTED TO SUPPORT THE RESTORATION GOALS AND DESIRED OUTCOMES. TREATMENTS ARE NATIVE MATERIALS BASED AND DESIGNED TO MIMIC REFERENCE REACH CONDITIONS OBSERVED UPSTREAM IN RELATIVELY UNDISTURBED SEGMENTS OF O'BRIEN CREEK. STREAMBED TREATMENTS WILL CONSIST OF COMPLEX AQUATIC HABITAT FEATURES INCLUDING RIFFLES, PLUNGE POOLS, LATERAL POOLS AND GLIDES. STREAMBANK TREATMENTS WILL BE COMPOSED OF WOOD, ALLUVIUM, AND VEGETATION, AND WILL INCREASE BANK RESILIENCY TO EROSION. PROVIDING SHORT-TERM STREAMBED AND STREAMBANK STABILITY IS REQUIRED TO SUPPORT THE VEGETATION DESIGN WHICH EMPHASIZES CREATING A SELF-SUSTAINING MOSAIC OF RIPARIAN AND WETLAND COMMUNITIES ON A FLOODPLAIN SURFACE THAT IS HYDROLOGICALLY CONNECTED TO THE CHANNEL. FLOODPLAIN TREATMENTS WILL INCLUDE A VARIETY OF VEGETATION COVER TYPES THAT INTEGRATE PLANT SPECIES COMPOSITION WITH GEOMORPHOLOGY AND HYDROLOGY, AND ACCOUNT FOR ECOLOGICAL PROCESSES THAT SUPPORT PLANT COMMUNITY DEVELOPMENT OVER TIME.

ACTIVE CHANNEL RESTORATION IS NOT PROPOSED IN REACH 3. RESTORATION GOALS IN REACH 3 FOCUS ON LOWERING HIGH, ERODING BANKS TO BANKFULL ELEVATION, AND CREATING A 35-FT. WIDE, WELL-VEGETATED FLOODPLAIN CORRRIDOR THAT INTERACTS WITH THE CHANNEL AT BANKFULL STAGE.

RDG RIVER DESIGN GROUP
236 Wisconsin Avenue Whitefish, MT 59937 406.862.4927
311 SW Jefferson Avenue Corvallis, OR 97333 541.738.2920

SITE PLAN AND INDEX

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
3.0

Drawing .0 of 16

\\rdgvfs\Projects\2021\RDG-21-169 O'Brien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

TOTAL WOOD QUANTITIES

ITEM	QUANTITY	DIAMETER	LENGTH	ROOTWAD
CATEGORY 1 WOOD	73	10 -12 IN	25 FT	YES
CATEGORY 2 WOOD	1,313	3 - 6 IN	20 FT	OPTIONAL
CATEGORY 3 WOOD	4,910	< 3 IN	10 - 12 FT	OPTIONAL
WILLOW CUTTINGS	10,350	0.25 - 1.0 IN	8 FT	NO

NOTE: WOOD LENGTHS SHOWN WILL PRODUCE THE PROPER AMOUNT MATERIAL FOR STRUCTURES WHEN SPLIT INTO APPROPRIATE SIZES DURING CONSTRUCTION. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.

TOTAL ROCK QUANTITIES

ITEM	QUANTITY	DIAMETER
CATEGORY 1 ROCK	360 EA	12 - 18 IN

ITEM	QUANTITY	GRADATION		
		SIZE (IN)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
STREAMBED/STREAMBANK FILL	370 CY	6	95	D100
		5	90-95	D95
		4	85-90	D84
		3	65-85	D65
		2	50-65	D50
		1	30-50	D35
		0.5	20-30	D15
		0.08	20	

EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	1,505
BACKFILL	705
NET CUT	800

NOTE: VOLUMES ARE NEATLINE, CONTRACTOR TO APPLY EXPANSION FACTORS TO DETERMINE A MORE ACCURATE BACKFILL VOLUME.

LARGE WOOD STRUCTURE QUANTITIES

ITEM	QUANTITY
LARGE WOOD STRUCTURES	**9**
CATEGORY 1 WOOD	45
CATEGORY 2 WOOD	36
CATEGORY 3 WOOD	90
WILLOW CUTTINGS	900

VEGETATED WOOD MATRIX QUANTITIES

ITEM	QUANTITY
VEGETATED WOOD MATRIX TYPE 1	**930**
VEGETATED WOOD MATRIX TYPE 2	**500**
VEGETATED WOOD MATRIX TYPE 3	**300**
CATEGORY 2 WOOD	1,223
CATEGORY 3 WOOD	4,470
WILLOW CUTTINGS	8,575
STREAMBANK FILL	200

VEGETATED BRUSH TRENCH QUANTITIES

ITEM	QUANTITY
VEGETATED BRUSH TRENCH	**175**
CATEGORY 3 WOOD	**350**
WILLOW CUTTINGS	**875**

CONSTRUCTED CHANNEL STREAMBED QUANTITIES

ITEM	QUANTITY
CONSTRUCTED RIFFLE	**575**
CATEGORY 1 ROCK	333
STREAMBED FILL	167
CATEGORY 2 WOOD	33

LOG STEP POOL QUANTITIES

ITEM	QUANTITY
LOG STEP STRUCTURES	**7**
CATEGORY 1 WOOD	**28**
CATEGORY 2 WOOD	**21**
CATEGORY 1 ROCK	**28**
FILTER FABRIC	**120**
RING SHANK NAILS	**140**

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

MATERIALS AND QUANTITES

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

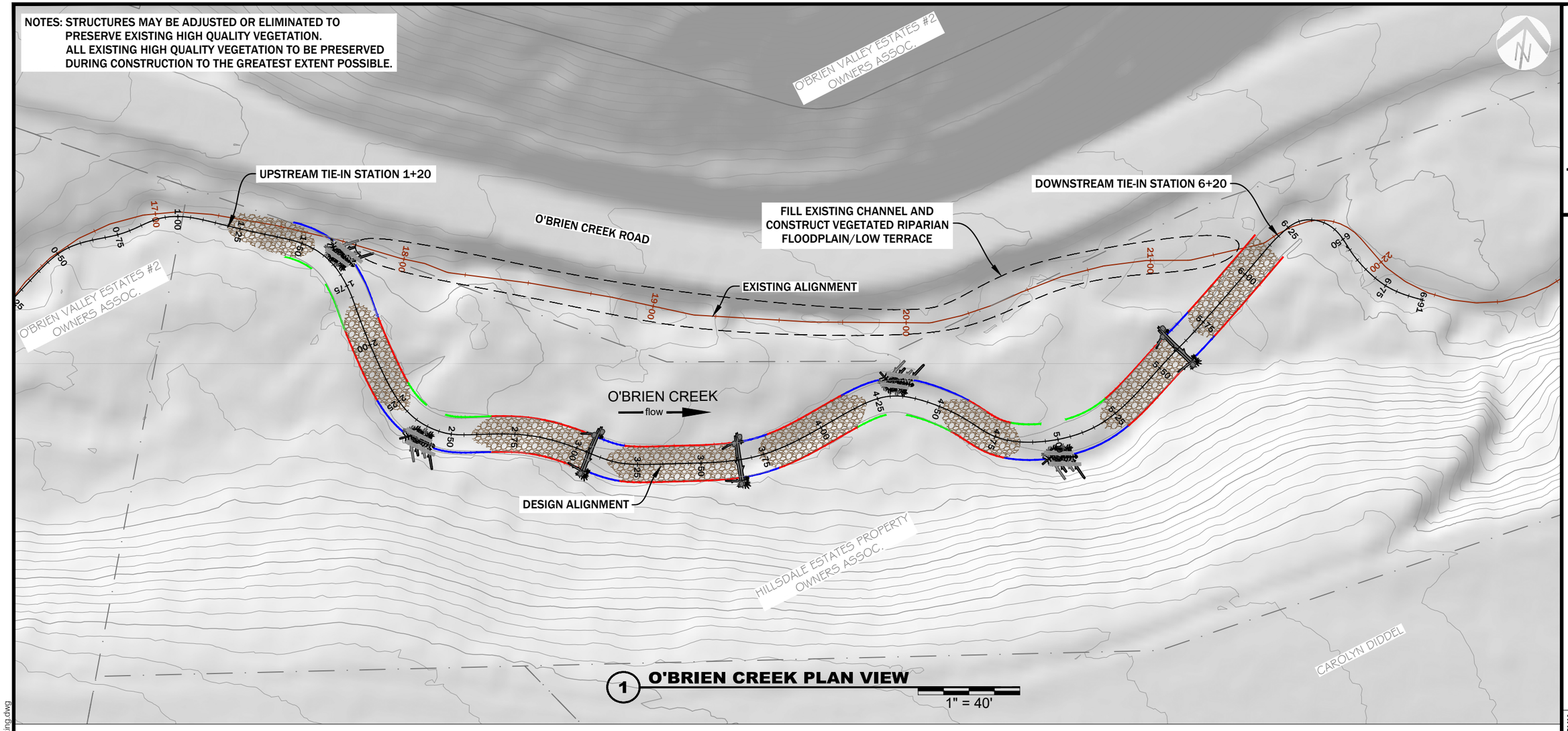
PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
4.0

Drawing .0 of 16

\\rdgfs\Projects\2021\RDG-21-169 O'Brien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

NOTES: STRUCTURES MAY BE ADJUSTED OR ELIMINATED TO PRESERVE EXISTING HIGH QUALITY VEGETATION.
ALL EXISTING HIGH QUALITY VEGETATION TO BE PRESERVED DURING CONSTRUCTION TO THE GREATEST EXTENT POSSIBLE.



1 O'BRIEN CREEK PLAN VIEW
1" = 40'

LEGEND

BANK STRUCTURES	DETAIL SHEET #
LARGE WOOD STRUCTURE (LWS)	7.0
LOG STEP POOL STRUCTURE (LWS)	7.3
VEGETATED WOOD MATRIX TYPE 1 (VWM 1)	7.1
VEGETATED WOOD MATRIX TYPE 2 (VWM 2)	7.1
VEGETATED WOOD MATRIX TYPE 3 (VWM 3)	7.1
CHANNEL STRUCTURES	
CONSTRUCTED CHANNEL STREAMBED (CCS)	7.2

CHANNEL TOP OF BANK ELEVATIONS

STATION	ELEVATION (FT)	STATION	ELEVATION (FT)
1+50	3200.9	4+00	3194.4
2+00	3199.8	4+50	3193.3
2+50	3198.7	5+00	3192.2
3+00	3196.6	5+50	3191.1
3+50	3195.5	6+00	3190.0

STRUCTURE SCHEDULE

STATION START	STATION END	BANK	STRUCTURE	STATION START	STATION END	BANK	STRUCTURE	STATION START	STATION END	BANK	STRUCTURE
1+20	1+52	C	CCS	3+05	3+19	L	VWM 2	4+48	4+87	C	CCS
1+45	1+59	L	VWM 2	3+05	3+19	R	VWM 2	4+59	4+80	L	VWM 1
1+45	1+59	R	VWM 3	3+05	3+19	C	LSP	4+59	4+80	R	VWM 1
1+59	1+70	L	LWS	3+13	3+65	C	CCS	4+80	4+94	L	VWM 3
1+70	1+91	L	VWM 2	3+19	3+65	L	VWM 1	4+80	4+94	R	VWM 2
1+70	1+91	R	VWM 3	3+19	3+65	R	VWM 1	4+94	5+05	R	LWS
1+80	2+27	C	CCS	3+65	3+79	L	VWM 2	5+05	5+26	L	VWM 3
1+91	2+20	L	VWM 1	3+65	3+79	R	VWM 2	5+05	5+26	R	VWM 2
1+91	2+20	R	VWM 1	3+65	3+79	C	LSP	5+15	5+61	C	CCS
2+20	2+34	L	VWM 3	3+73	4+13	C	CCS	5+26	5+60	L	VWM 1
2+20	2+34	R	VWM 2	3+79	4+13	L	VWM 1	5+26	5+60	R	VWM 1
2+34	2+45	R	LWS	3+79	4+13	R	VWM 1	5+60	5+74	L	VWM 2
2+45	2+66	L	VWM 3	4+13	4+27	L	VWM 2	5+60	5+74	R	VWM 2
2+45	2+66	R	VWM 2	4+13	4+27	R	VWM 3	5+60	5+74	C	LSP
2+55	3+05	C	CCS	4+27	4+38	L	LWS	5+68	6+25	C	CCS
2+66	3+05	L	VWM 1	4+38	4+59	L	VWM 2	5+74	6+25	L	VWM 1
2+66	3+05	R	VWM 1	4+38	4+59	R	VWM 3	5+74	6+25	R	VWM 1

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

PLAN VIEW AND DATA SHEET REACH 1

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

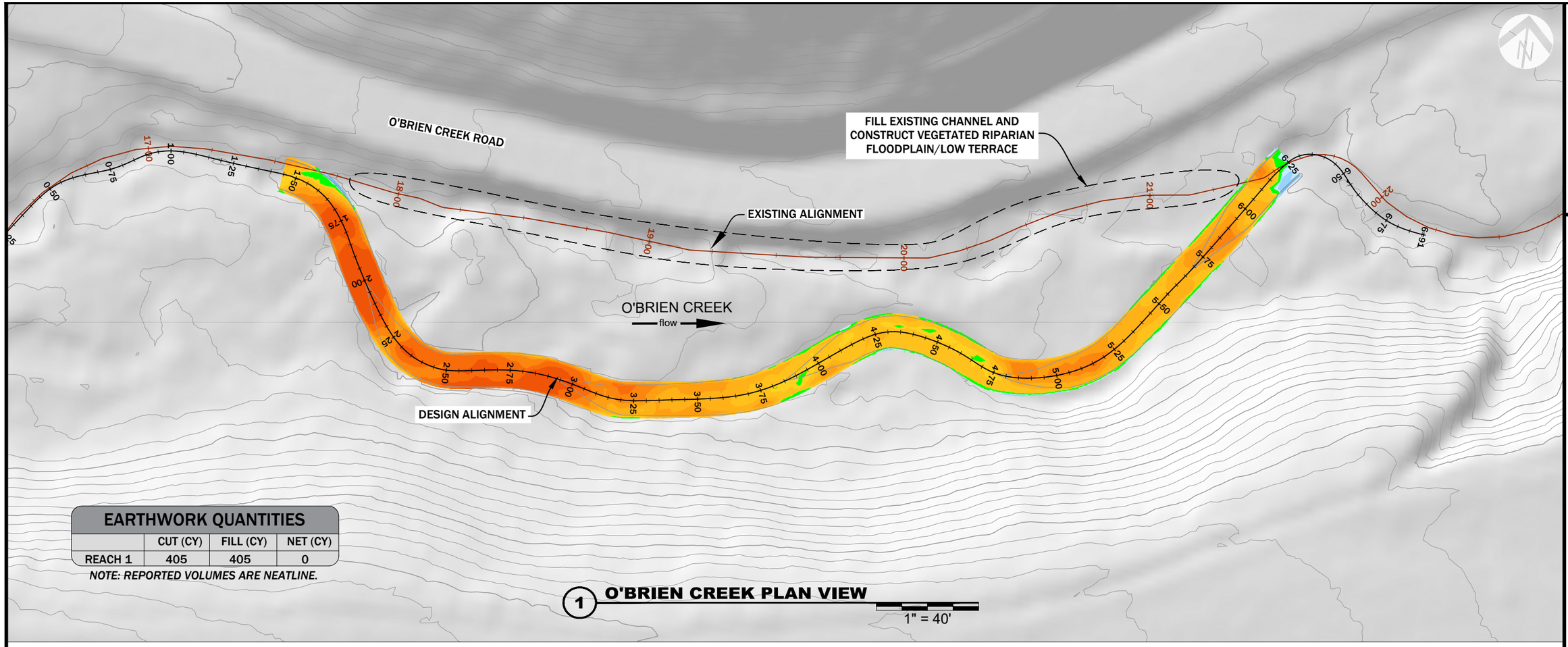
NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
5.0

Drawing .0 of 16

\\rdgfs\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

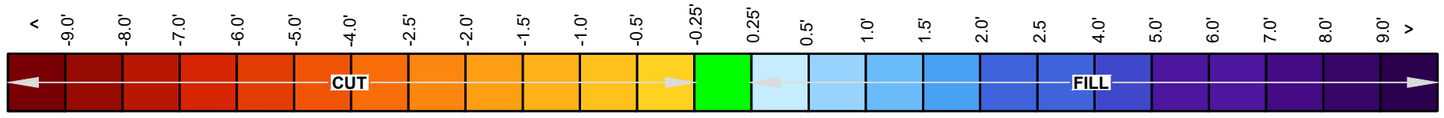


EARTHWORK QUANTITIES			
	CUT (CY)	FILL (CY)	NET (CY)
REACH 1	405	405	0

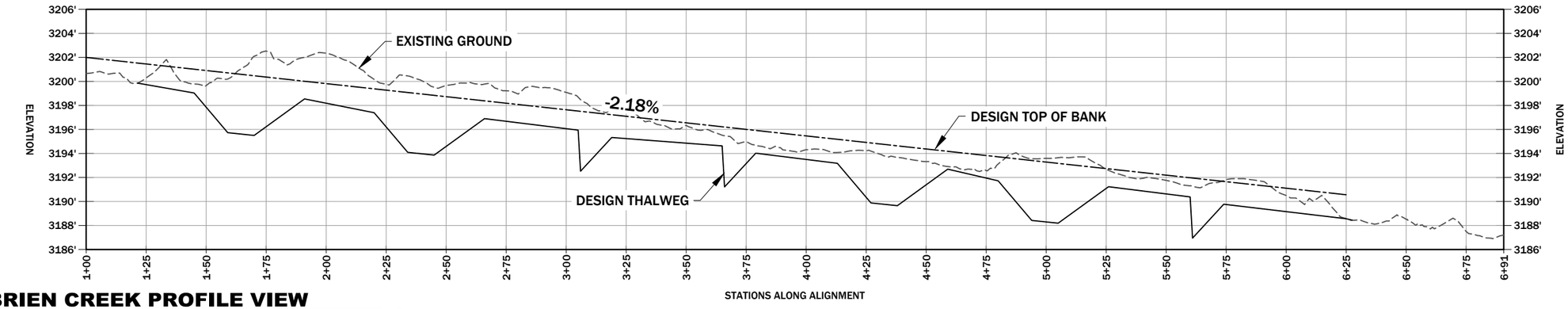
NOTE: REPORTED VOLUMES ARE NEATLINE.

1 O'BRIEN CREEK PLAN VIEW

1" = 40'



EXISTING GROUND COMPARED TO RDG DESIGN RIFFLE TEMPLATE (POOL FEATURES WILL BE ADDED IN FINAL DESIGN)



2 O'BRIEN CREEK PROFILE VIEW

1" = 50'

\\rdg\wf\Projects\2021\RDG-21-169 O'Brien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

RDG RIVER DESIGN GROUP
236 Wisconsin Avenue 311 SW Jefferson Avenue
Whitefish, MT 59937 Corvallis, OR 97333
406.862.4927 541.738.2920

PLAN VIEW AND DATA SHEET REACH 1

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

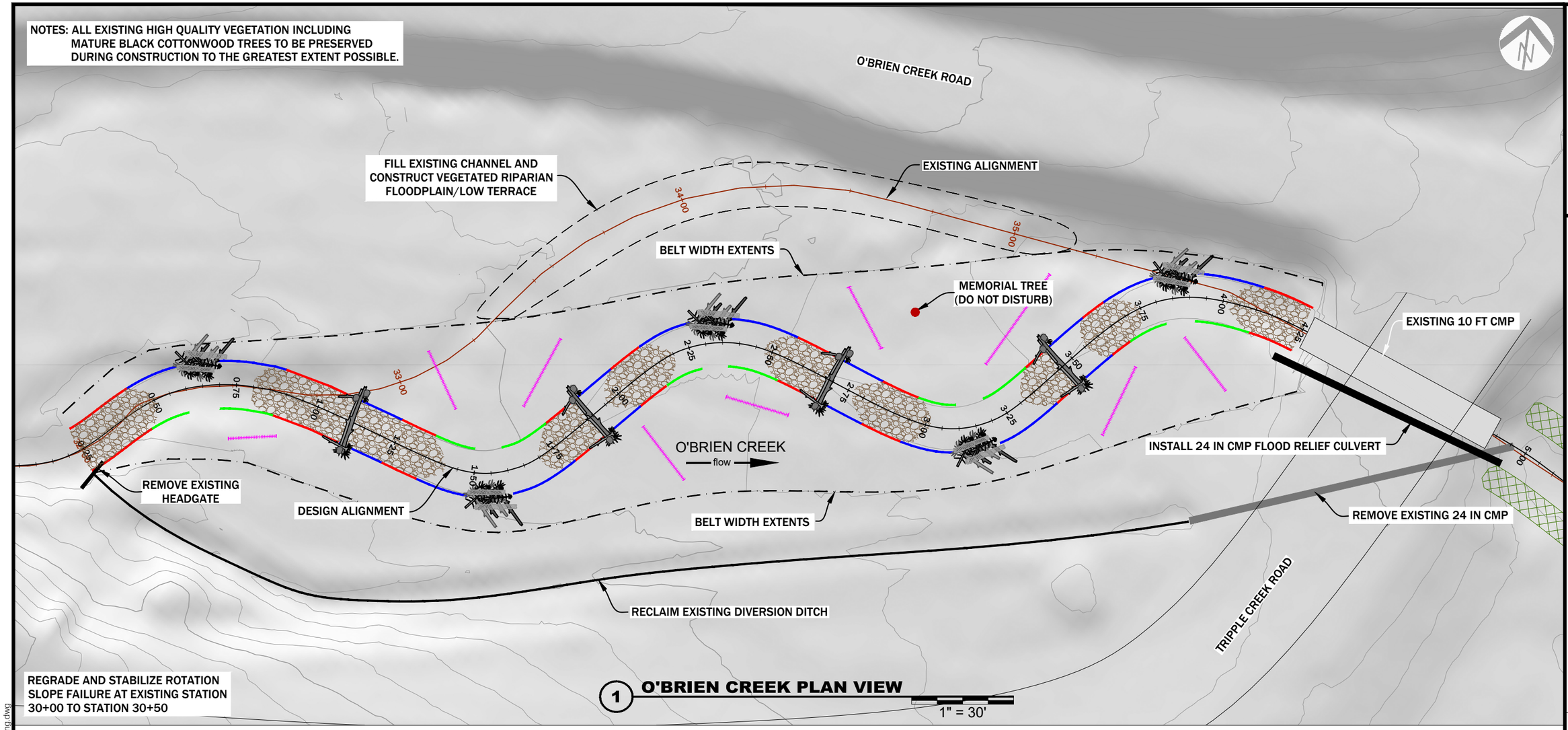
NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
5.1

Drawing .1 of 16

NOTES: ALL EXISTING HIGH QUALITY VEGETATION INCLUDING MATURE BLACK COTTONWOOD TREES TO BE PRESERVED DURING CONSTRUCTION TO THE GREATEST EXTENT POSSIBLE.



1 O'BRIEN CREEK PLAN VIEW

1" = 30'

LEGEND

	BANK STRUCTURES	DETAIL SHEET #
	LARGE WOOD STRUCTURE (LWS)	7.0
	LOG STEP POOL STRUCTURE (LWS)	7.3
	VEGETATED WOOD MATRIX TYPE 1 (VWM 1)	7.1
	VEGETATED WOOD MATRIX TYPE 2 (VWM 2)	7.1
	VEGETATED WOOD MATRIX TYPE 3 (VWM 3)	7.1
	VEGETATED BRUSH TRENCH (VBT)	7.4
	CHANNEL STRUCTURES	
	CONSTRUCTED CHANNEL STREAMBED (CCS)	7.2

CHANNEL TOP OF BANK ELEVATIONS

STATION	ELEVATION (FT)
1+00	3161.6
1+50	3160.4
2+00	3159.2
2+50	3158.1
3+00	3156.9
3+50	3155.7
4+00	3154.6

STRUCTURE SCHEDULE

STATION START	STATION END	BANK	STRUCTURE
0+25	0+52	CCS	C
0+25	0+45	VWM 1	L
0+25	0+45	VWM 1	R
0+45	0+59	VWM 2	L
0+45	0+59	VWM 3	R
0+59	0+70	LWS	L
0+70	0+88	VWM 2	L
0+70	0+88	VWM 3	R
0+79	0+88	CCS	C
0+80	1+35	VWM 1	R
0+88	1+10	VWM 1	L
0+88	1+10	VWM 1	R
1+10	1+24	VWM 2	L
1+10	1+24	VWM 2	R
1+24	1+35	VWM 1	L
1+24	1+35	VWM 1	R
1+35	1+49	VWM 3	L
1+35	1+49	VWM 2	R
1+49	1+60	LWS	R
1+60	1+78	VWM 3	L
1+60	1+78	VWM 2	R
1+69	1+90	CCS	C
1+78	1+89	VWM 1	L
1+78	1+89	VWM 1	R
1+89	2+03	LSP	C
1+89	2+03	VWM 2	L
1+89	2+03	VWM 2	R
1+97	2+20	CCS	C
2+03	2+13	VWM 1	L
2+03	2+13	VWM 1	R
2+13	2+27	VWM 2	L
2+13	2+27	VWM 3	R
2+27	2+37	LWS	L
2+37	2+55	VWM 2	L
2+37	2+55	VWM 3	R
2+46	2+69	CCS	C
2+55	2+69	VWM 1	L
2+55	2+69	VWM 1	R
2+69	2+83	LSP	C
2+69	2+83	VWM 2	L
2+69	2+83	VWM 2	R
2+76	3+02	CCS	C
2+83	2+95	VWM 1	L
2+83	2+95	VWM 1	R
2+95	3+09	VWM 3	L
2+95	3+09	VWM 2	R
3+09	3+20	LWS	R
3+20	3+38	VWM 3	L
3+20	3+38	VWM 2	R
3+29	3+47	CCS	C
3+38	3+46	VWM 1	L
3+38	3+46	VWM 1	R
3+46	3+60	LSP	C
3+46	3+60	VWM 2	L
3+46	3+60	VWM 2	R
3+54	3+74	CCS	C
3+60	3+67	VWM 1	L
3+60	3+67	VWM 1	R
3+67	3+81	VWM 2	L
3+67	3+81	VWM 3	R
3+81	3+92	LWS	L
3+92	4+10	VWM 2	L
3+92	4+10	VWM 3	R
4+01	4+25	CCS	C
4+10	4+25	VWM 1	L
4+10	4+25	VWM 1	R
1+10	1+24	LSP	C

RDG RIVER DESIGN GROUP
236 Wisconsin Avenue Whitefish, MT 59937 406.862.4927
311 SW Jefferson Avenue Corvallis, OR 97333 541.738.2920

PLAN VIEW AND DATA SHEET REACH 2

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER RDG-21-169

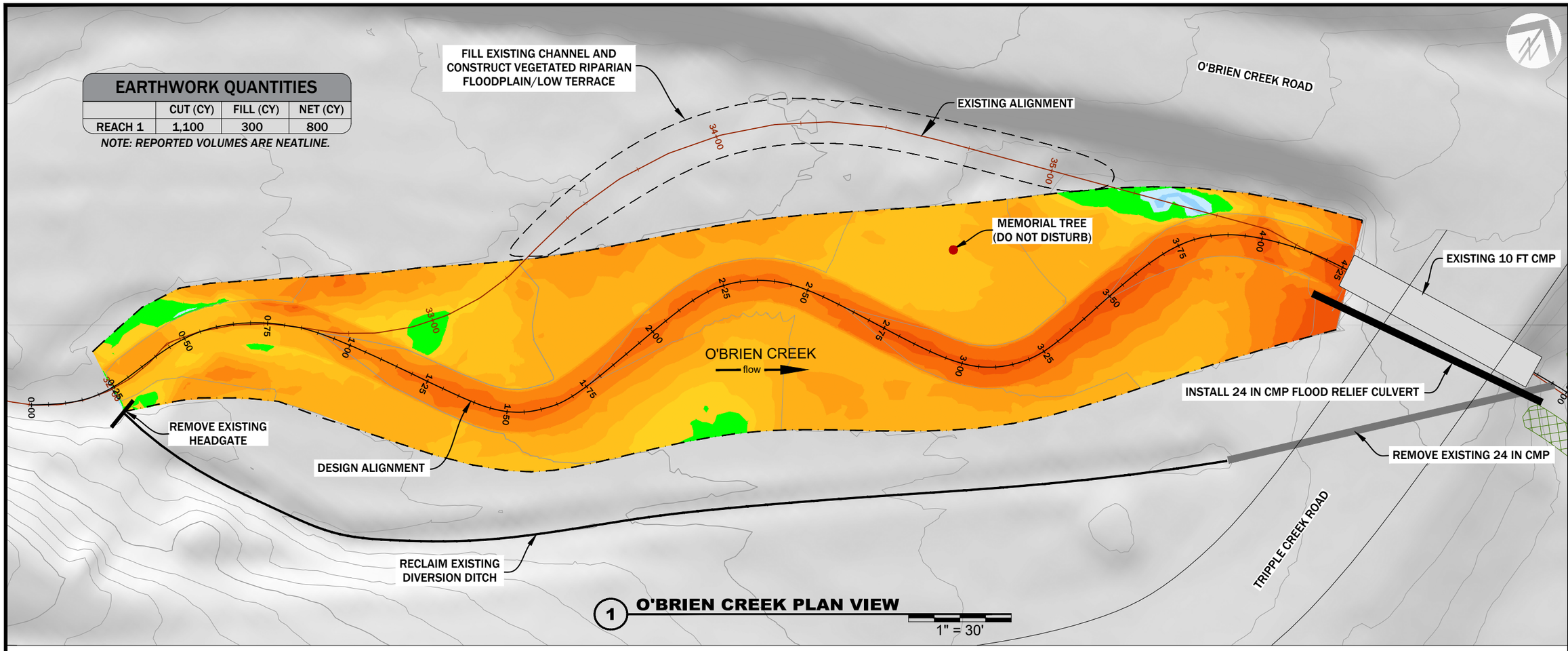
DRAWING NUMBER 5.2

Drawing .2 of 16

\\rdgfs\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

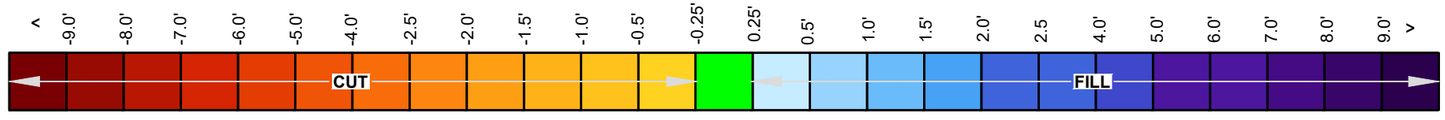
EARTHWORK QUANTITIES			
	CUT (CY)	FILL (CY)	NET (CY)
REACH 1	1,100	300	800

NOTE: REPORTED VOLUMES ARE NEATLINE.

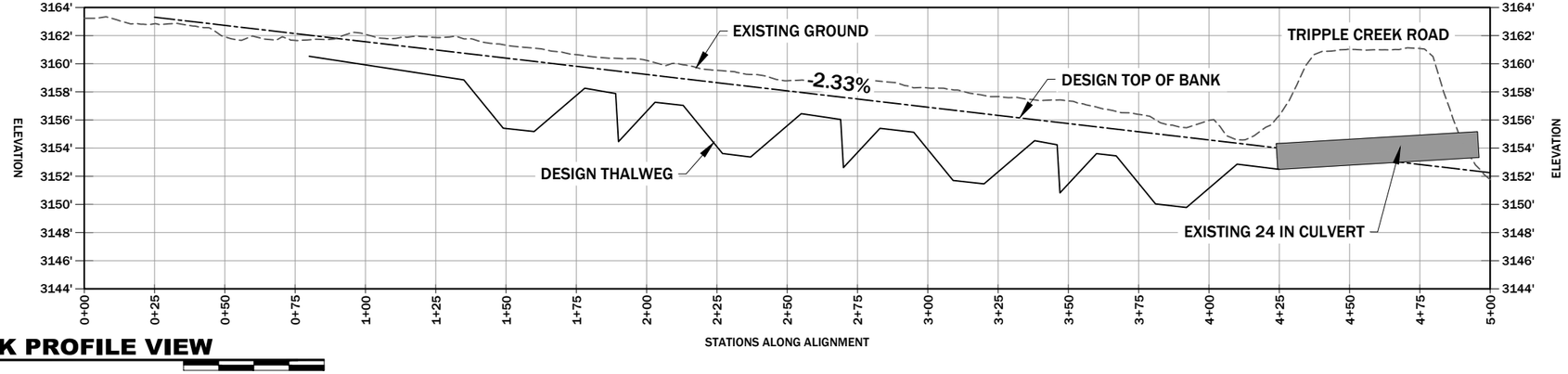


1 O'BRIEN CREEK PLAN VIEW

1" = 30'



EXISTING GROUND COMPARED TO RDG DESIGN RIFFLE TEMPLATE (POOL FEATURES WILL BE ADDED IN FINAL DESIGN)



2 O'BRIEN CREEK PROFILE VIEW

1" = 50'

RDG RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

PLAN VIEW AND DATA SHEET REACH 2

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

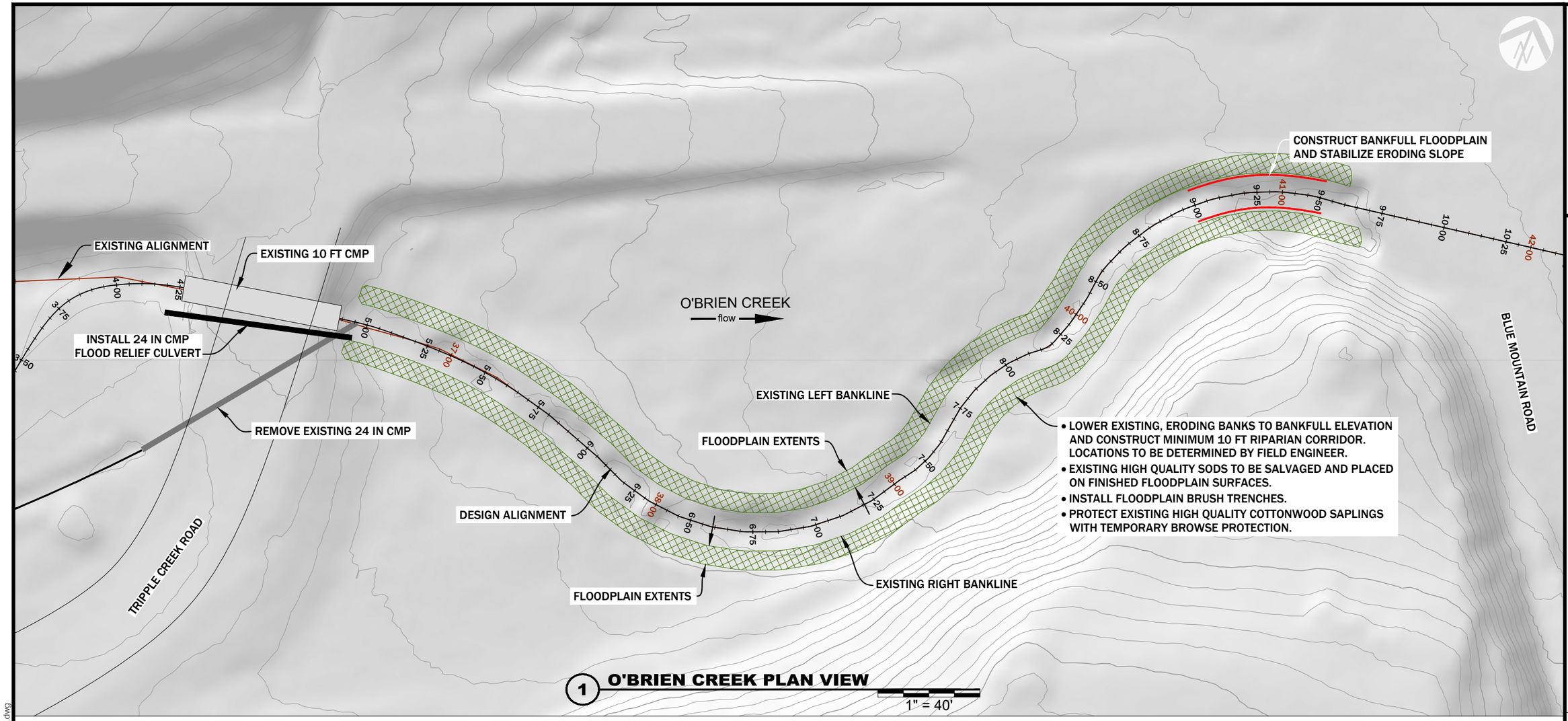
NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
5.3

Drawing .3 of 16

\\rdg\wf\Projects\2021\RDG-21-169 O'Brien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg



1 **O'BRIEN CREEK PLAN VIEW**

1" = 40'

REACH 3 DESCRIPTION

REACH 3 IS CHARACTERIZED AS A MODERATELY ENTRENCHED TO ENTRENCHED, RIFFLE-POOL STREAM TYPE CHARACTERIZED PRIMARILY BY PLANE BED MORPHOLOGY AND DISCONNECTED FLOODPLAIN SURFACES. HISTORICAL STRAIGHTENING OF THE CHANNEL RESULTED IN CHANNEL DOWNCUTTING, INCISION, AND SIMPLIFICATION OF AQUATIC HABITAT. THE EXISTING RIPARIAN CORRIDOR IS CHARACTERIZED BY A MATURE COTTONWOOD GALLERY WITH UNDERSTORY VEGETATION CONSISTING OF COTTONWOOD SAPLINGS RIPARIAN SHRUBS. RESTORATION STRATEGIES IN REACH 3 FOCUS ON LOWERING HIGH BANKS (I.E. REDUCING BANK HEIGHT RATIOS) TO BANKFULL ELEVATION AND EXPANDING THE FLOODPLAIN OPPORTUNISTICALLY IN AREAS WHERE IMPACTS TO EXISTING COTTONWOOD TREES CAN BE AVOIDED. FOR THESE SEGMENTS, EXISTING SODS AND SHRUBS WILL BE STRIPPED AND TEMPORARILY STOCKPILED. BANKS WILL BE LOWERED TO DESIGN ELEVATIONS, AND SALVAGED SODS WILL BE PLACED ON NEWLY FORMED FLOODPLAIN SURFACES. FLOODPLAIN BRUSH TRENCHES CONSISTING OF WILLOW CUTTINGS AND SMALL DIAMETER WOODY MATERIAL WILL BE INSTALLED TO PROMOTE WILLOW ESTABLISHMENT AND INCREASE FLOODPLAIN ROUGHNESS.

EXISTING COTTONWOOD SAPLINGS WILL BE PROTECTED WITH INDIVIDUAL WIRE MESH BROWSE PROTECTORS ATTACHED TO T-POSTS. THE FINAL DESIGN PHASE OF THIS PROJECT WILL DETERMINE EXACT LOCATIONS WHERE BROWSE PROTECTION WILL BE INSTALLED. ALTERNATIVE MEASURES MAY BE CONSIDERED, INCLUDING TEMPORARY EXCLOSURE FENCING.

STRUCTURE SCHEDULE

STATION START	STATION END	BANK	STRUCTURE
9+00	9+50	VWM 1	L
9+00	9+50	VWM 1	R

RDG
RIVER DESIGN GROUP
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920

PLAN VIEW AND DATA SHEET REACH 3

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

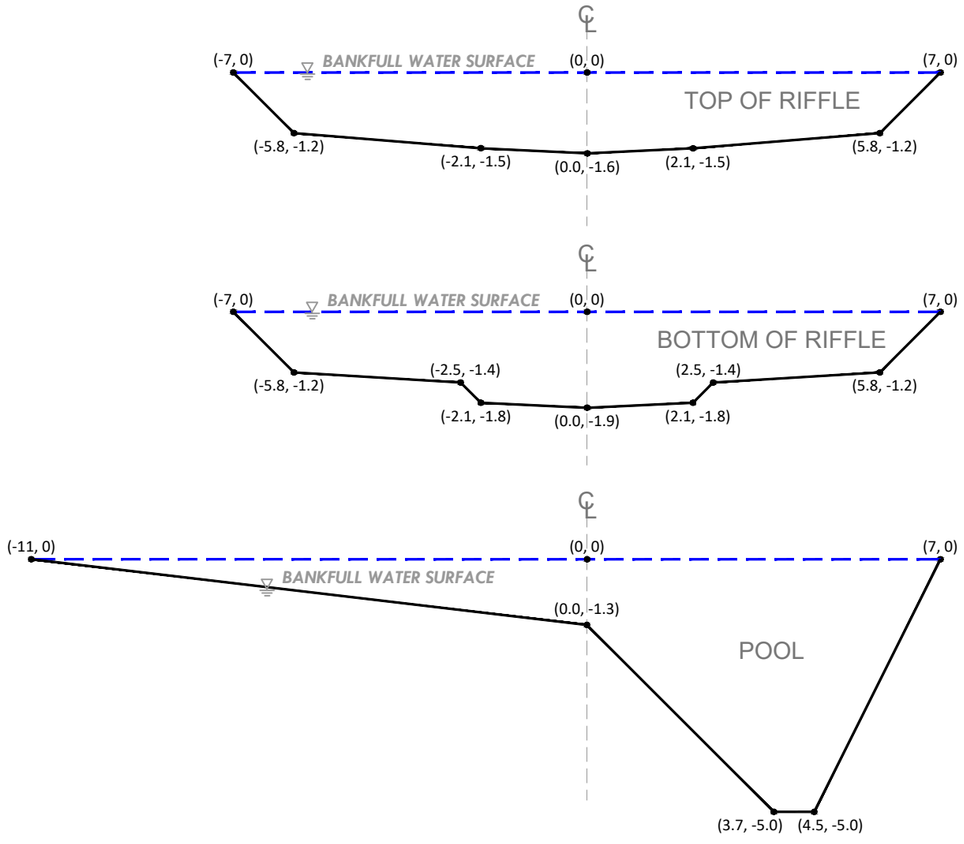
DRAWING NUMBER
5.4

Drawing .4 of 16

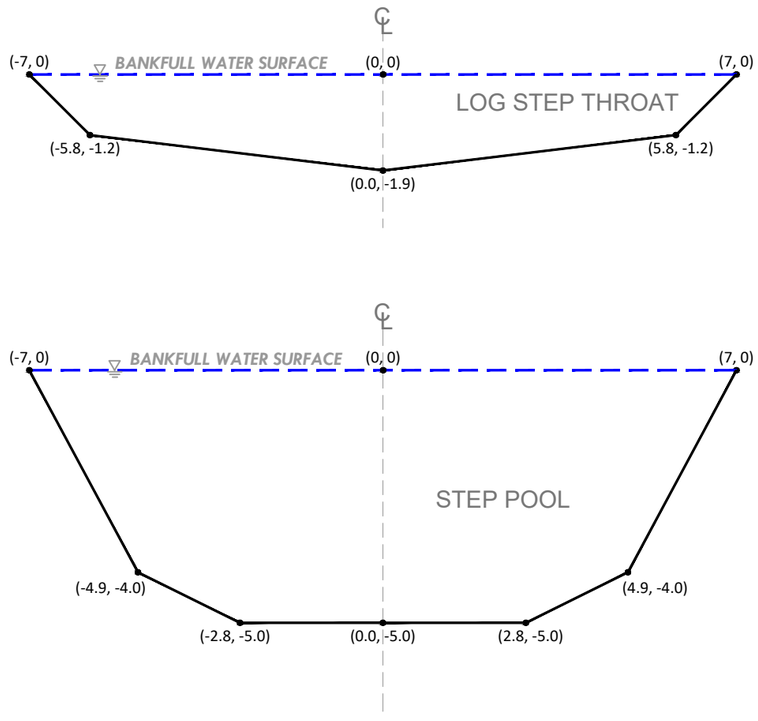
DESIGN CHANNEL DIMENSIONS

BANKFULL CHANNEL DESIGN CRITERIA	
STREAM TYPE	B4
DISCHARGE	80-100 CFS
VALLEY SLOPE	0.026 - 0.031 FT/FT
SINUOSITY	1.2
CHANNEL SLOPE	0.022 - 0.026 FT/FT

PARAMETER / FEATURE	RIFFLE	POOL
WIDTH	13-16 ft	17-20 ft
MEAN DEPTH	1.1-1.3 ft	1.2-1.4 ft
MAX. DEPTH	1.6-2.1 ft	3.7-5.0 ft
XS AREA	17 sq ft	24 sq ft
WIDTH:DEPTH	10-14	12-16



CHANNEL CROSS SECTIONS
TYPICAL
0' 1.5' 3'



CHANNEL CROSS SECTIONS
TYPICAL
0' 1.5' 3'

NOTE: COORDINATES ARE REFERENCED FROM TOP OF BANK THALWEG

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

DESIGN CROSS SECTIONS

O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
6.0

Drawing .0 of 16

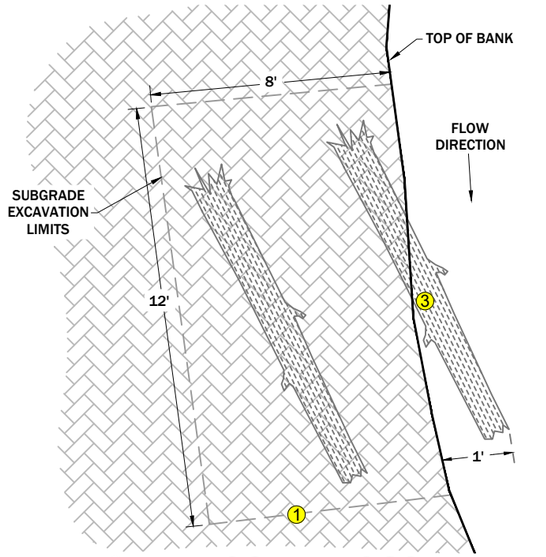
\\rdg\wt\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

GENERAL NOTES

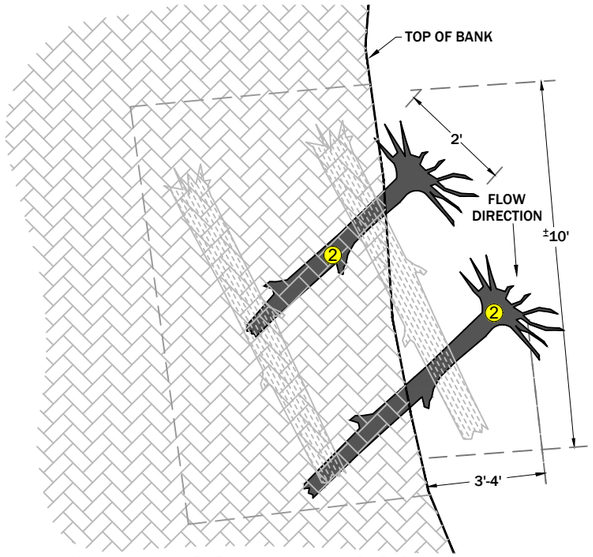
1. CONSTRUCTION OF THE LARGE WOOD STRUCTURE WILL OCCUR AFTER THE STREAMBANK SUBGRADE AND CHANNEL STREAMBED SUBGRADE IS ESTABLISHED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH LARGE WOOD STRUCTURE PRIOR TO CONSTRUCTION

CONSTRUCTION NOTES

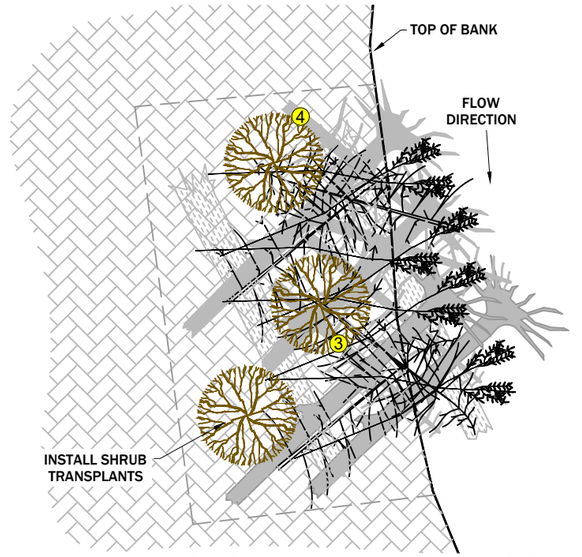
1. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. INSTALL TWO FOOTER LOGS (CATEGORY 2 WOOD) AT THE BASE OF THE EXCAVATED TRENCH AT THE ORIENTATIONS NOTED IN PLAN VIEW. FOOTER LOGS SHALL PROJECT NO GREATER THAN 1 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
3. INSTALL TWO ROOTWAD LOGS (CATEGORY 1 WOOD) INTERSECTING BOTH FOOTER LOGS AT THE ORIENTATION NOTED IN PLAN VIEW. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
4. BACKFILL TRENCH WITH STOCKPILED MATERIAL UP TO THE TOP OF THE FOOTER LOGS (CATEGORY 2 WOOD). BACKFILL SHALL BE BUCKET COMPACTED.
5. INSTALL A SECOND TIER OF TWO FOOTER LOG (CATEGORY 2 WOOD) FOOTER LOGS SHALL PROJECT NO GREATER THAN 1 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
6. INSTALL SMALL WOOD AND BRUSH (CATEGORY 3 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
7. INSTALL ONE TO TWO ROOTWAD LOGS (CATEGORY 1 WOOD) INTERSECTING THE LOWER TIER OF ROOTWADS AT THE ORIENTATION NOTED IN PLAN VIEW. THE ROOTWADS SHALL PROJECT NO GREATER THAN 2 FT. BEYOND THE FINISHED BANK LINE.
8. INSTALL SMALL WOOD AND BRUSH (CATEGORY 3 WOOD) AND WILLOW CUTTINGS INTERWOMEN INTO WOOD MATRIX UP TO FINISHED GRADE. BRUSH, LIMBS, AND WILLOW CUTTINGS SHALL PROJECT NO GREATER THAN 4 FT. BEYOND THE FINISHED BANK LINE.
9. BACKFILL WOOD MATRIX WITH STREAMBED FILL UP TO FINISHED GRADE WITH STOCKPILED NATIVE MATERIAL. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.
10. INSTALL DEFLECTOR LOGS (CATEGORY 2 WOOD)) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. DEFLECTOR LOGS SHALL BE HALF EMBEDDED IN THE FLOODPLAIN AND PROJECT NO GREATER THAN 4 FT. BEYOND THE FINISHED BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.



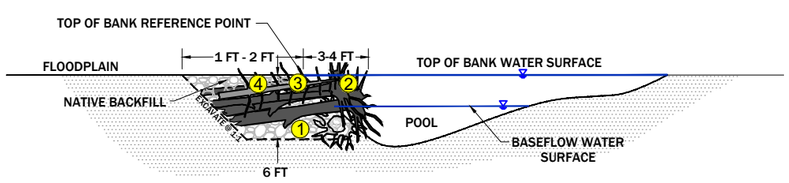
1 FOOTER LOGS PLAN VIEW 1" = 5'



2 ROOTWAD LOGS PLAN VIEW 1" = 5'



3 DEFLECTOR AND BRUSH WOOD PLAN VIEW 1" = 5'



4 LARGE WOOD STRUCTURE SECTION VIEW 1" = 5'

MATERIAL SCHEDULE (PER STRUCTURE)

ITEM	QUANTITY	DIA. (IN)	LENGTH (FT)	ROOTWAD (Y/N)
1 CY OF SUBGRADE EXCAVATION	15			
2 CATEGORY 1 WOOD	5	10-12	12-15	YES - 18 IN DIA. MIN.
3 CATEGORY 2 WOOD	4	3-10	10-15	NO
4 CATEGORY 3 WOOD	10	1-3	10-12	OPTIONAL 1-2 FT

RDG RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

LARGE WOOD STRUCTURE DETAIL

O'BRIEN CREEK RESTORATION PROJECT

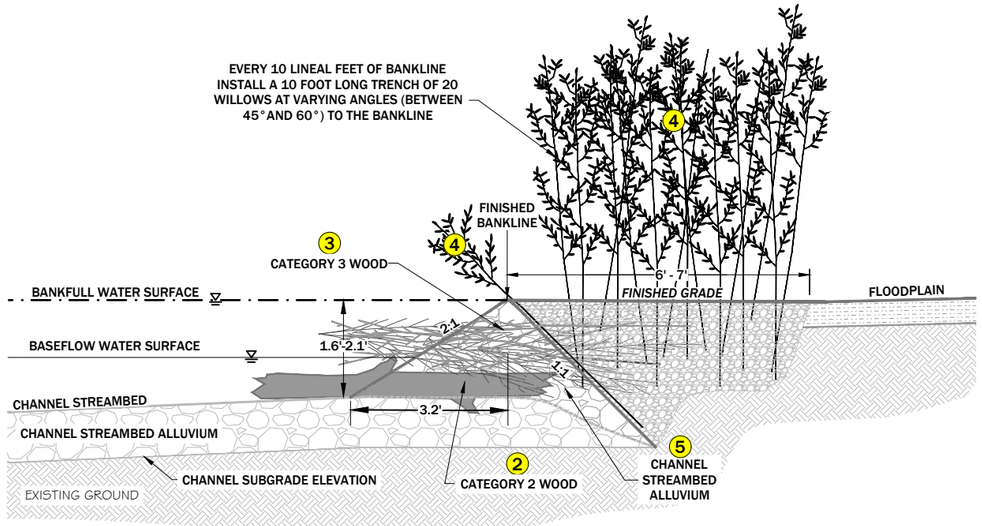
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

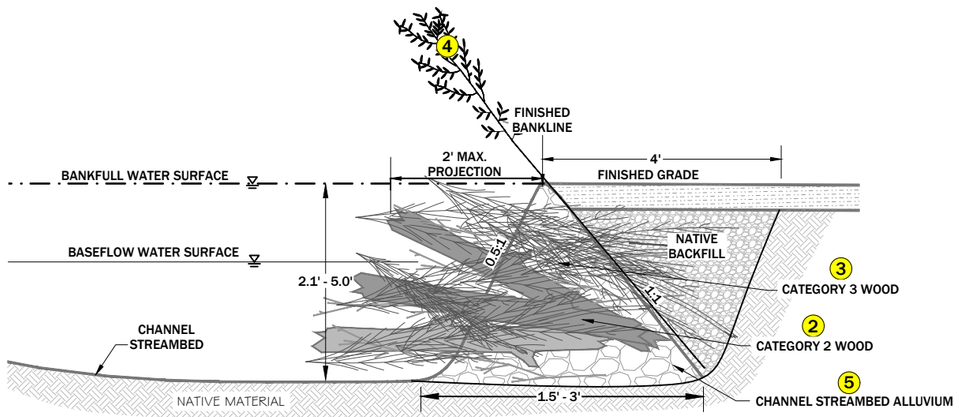
DRAWING NUMBER
7.0

Drawing .0 of 16



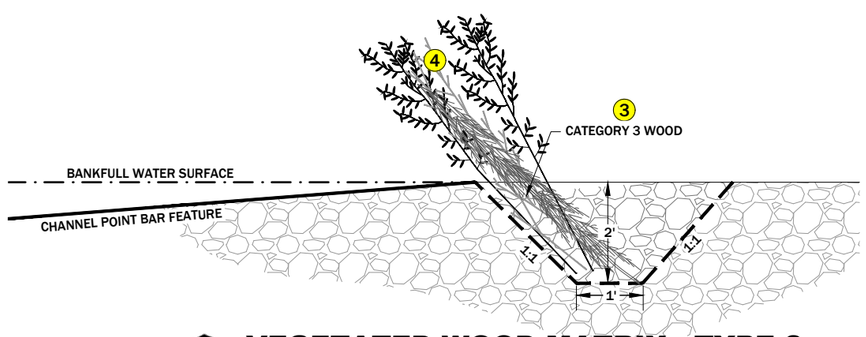
1 VEGETATED WOOD MATRIX - TYPE 1 SECTION VIEW

1" = 3'



2 VEGETATED WOOD MATRIX - TYPE 2 SECTION VIEW

1" = 3'



3 VEGETATED WOOD MATRIX - TYPE 3 SECTION VIEW

1" = 3'

GENERAL NOTES

1. CONSTRUCTION OF THE VEGETATED WOOD MATRIX WILL OCCUR AFTER THE CHANNEL AND FLOODPLAIN BACKFILL IS PLACED AND THE CHANNEL STREAMBED IS CONSTRUCTED. INSTALLATION OF FLOODPLAIN TREATMENT SHALL BE COMPLETED AFTER VEGETATED WOOD MATRIXES ARE INSTALLED.
2. IF VEGETATED WOOD MATRIX STRUCTURES ARE INSTALLED PRIOR TO OCTOBER 1, LEAVE BACK TRENCH UNFILLED AND COMPLETE STRUCTURE WHEN DORMANT WILLOWS ARE AVAILABLE.
3. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
4. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY CONSTRUCTION MANAGER.
5. CONTRACTOR SHALL MARK AND CONSTRUCTION ENGINEER SHALL APPROVE THE GENERAL LOCATION FOR EACH VEGETATED WOOD MATRIX STRUCTURE PRIOR TO CONSTRUCTION.

NOTES ON VEGETATED WOOD MATRIX INSTALLATION

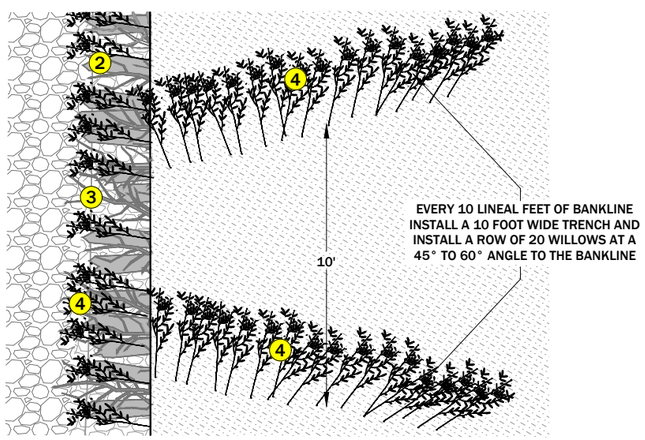
1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. PREPARE THE BENCH OF THE STRUCTURE BY PLACING CHANNEL STREAMBED ALLUVIUM FROM THE BASE OF THE EXCAVATION DEPTH/BOTTOM OF EXCAVATION TO WITHIN 1.0-FT. OF FINISHED GRADE.
3. CATEGORY 2 AND CATEGORY 3 WOOD, AND CHANNEL STREAMBED ALLUVIUM SHALL BE PLACED IN ALTERNATING LAYERS AND BUCKET COMPACTED UP TO THE TOP OF BANK ELEVATION AS SHOWN BELOW IN THE INSTALLATION SEQUENCE. PLACE SIX (6) FT TO EIGHT (8) FT. DORMANT WILLOW CUTTINGS AT A DENSITY OF 5 PER LINEAR FT ALONG THE TOP OF BANK LINE ELEVATION. WILLOW CUTTINGS SHALL SLOPE AT AN APPROXIMATE 1:1 SLOPE AS SHOWN IN SECTION VIEW. STEMS MAY OVERLAP. THE CUT ENDS SHALL BE PLACED AT THE BASE OF THE SLOPES WITH THE UN-CUT ENDS EXTENDING BEYOND THE EDGE OF THE TRENCH SO NO GREATER THAN ONE-THIRD OF THE TOTAL CUTTING LENGTH IS EXPOSED BEYOND THE TOP OF BANK EDGE. WILLOW CUTTINGS SHOULD INTERCEPT THE DESIGN TOP OF BANK LINE AS SHOWN IN STEP 5 OF THE INSTALLATION SEQUENCE.
4. THE UPSTREAM AND DOWNSTREAM ENDS OF THE STRUCTURE SHALL TRANSITION SMOOTHLY INTO ADJACENT STREAMBANK STRUCTURES TO MINIMIZE EROSION, FLANKING, AND BANK FAILURE. STRUCTURE ENDS MAY BE STABILIZED WITH ADDITIONAL CATEGORY 1 ROCK AS APPROVED BY ENGINEER.
5. AFTER INSTALLATION OF THE VEGETATED WOOD MATRIX, BACKFILL THE STRUCTURE WITH STOCKPILED MATERIAL TO FINISHED GRADE, AND BUCKET COMPACT. INSTALL WILLOW TRENCHES AT A RATE OF 2 PER LINEAR FOOT (OR 20 PER TRENCH) AS SHOWN. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.

STREAMBANK FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
6	95	D100
5	90-95	D95
4	85-90	D84
3	65 - 85	D65
2	50 - 65	D50
1	30 - 50	D35
0.5	10 - 30	D15
FINES	0-10	

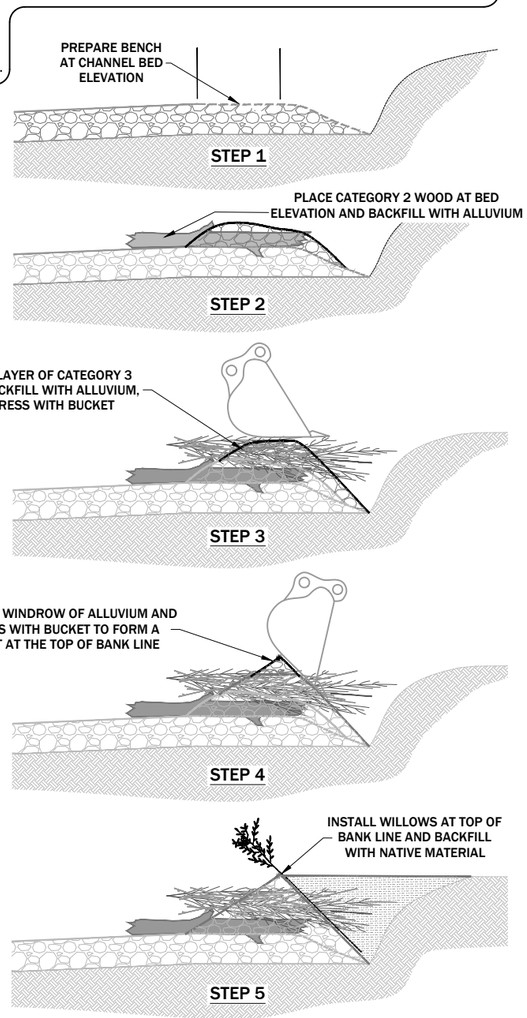
MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	DIA.	QUANTITY TYPE 1	TYPE 2	TYPE 3
2	CATEGORY 2 WOOD	3" - 6"	0.25	2	-
3	CATEGORY 3 WOOD	< 3"	2	5	0.5
4	WILLOW CUTTINGS	0.25" - 1"	5	5	3
5	STREAMBANK ALLUVIUM	6" MINUS	0.2 CY	0.6 CY	-



4 WILLOW TRENCH DETAIL PLAN VIEW

1" = 2'



5 RECOMMENDED VEGETATED WOOD MATRIX INSTALLATION SEQUENCE SECTION VIEW

1" = 5'

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

VEGETATED WOOD MATRIX DETAIL

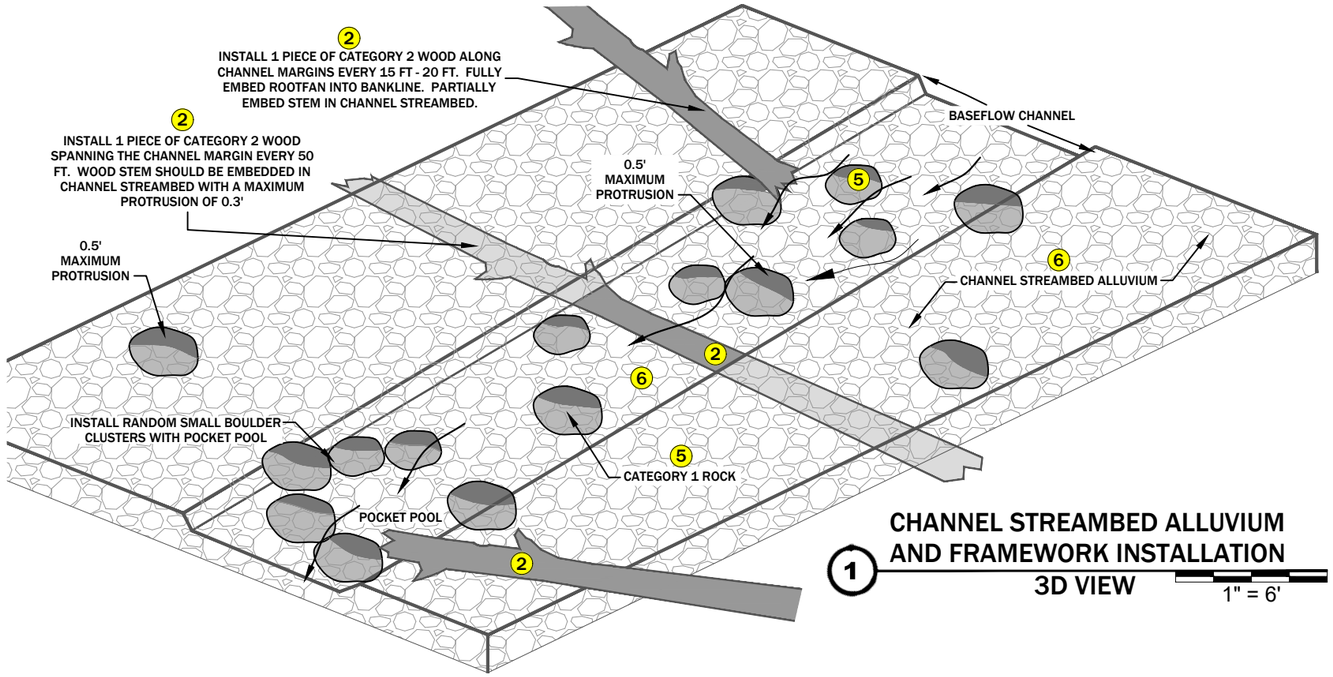
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

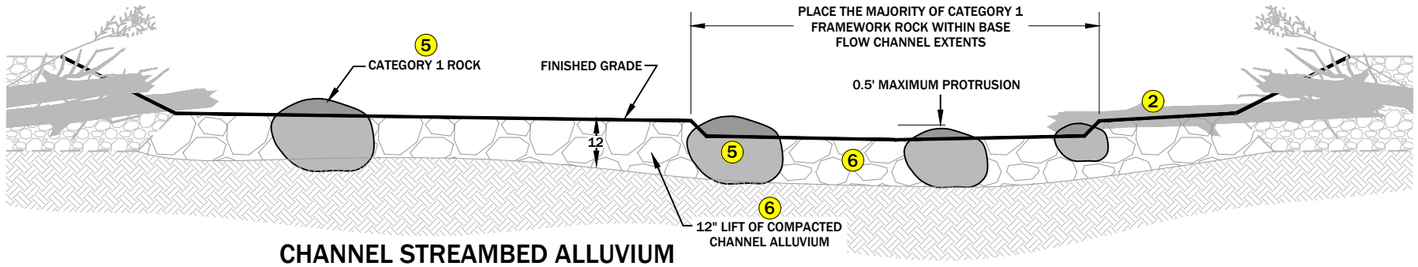
PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
7.1

Drawing .1 of 16



1 CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
3D VIEW 1" = 6'



2 CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
SECTION VIEW 1" = 4'

TYPICAL CONSTRUCTED STREAMBED THROUGH A RIFFLE FEATURE

TYPICAL CONSTRUCTED STREAMBED THROUGH A RUN FEATURE

GENERAL NOTES

1. CONSTRUCTION OF THE CHANNEL STREAMBED WILL OCCUR AFTER THE CHANNEL SUBGRADE IS PREPARED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE CONSTRUCTION MANAGER.
3. IT IS THE CONTRACTORS RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
4. CONTRACTOR SHALL MARK THE UPSTREAM AND DOWNSTREAM EXTENTS OF THE LOCATIONS OF THE CONSTRUCTED CHANNEL STREAMBED STRUCTURES.

NOTES ON CONSTRUCTED CHANNEL STREAMBED INSTALLATION

1. PRIOR TO CONSTRUCTION OF THE CHANNEL STREAMBED, CONSTRUCTION MANAGER SHALL VERIFY CHANNEL SUBGRADE ELEVATIONS. CHANNEL SUBGRADE SERVES AS THE FOUNDATION FOR THE CONSTRUCTED CHANNEL STREAMBED.
2. CONTRACTOR SHALL STOCKPILE CHANNEL ALLUVIUM PER SPECIFICATIONS NOTED ON THE DRAWING.
3. PREPARE THE FRAMEWORK. CONTRACTOR SHALL PLACE 12-INCH TO 18-INCH BOULDERS (CATEGORY 1 ROCK) ON THE SURFACE OF THE CHANNEL SUBGRADE PRIMARILY WITHIN THE LOW FLOW CHANNEL AS INDICATED ON THE DRAWING. DUE TO THE INHERENT VARIABILITY IN MATERIALS, BOULDER ELEVATIONS SHALL BE ADJUSTED TO ASSURE BOULDER PROTRUSION ABOVE FINISH GRADE WILL BE NO GREATER THAN 0.5-FT.
4. CONTRACTOR MAY INSTALL 12-INCH TO 18-INCH BOULDERS (CATEGORY 1 ROCK) IN CLUSTERS, AS DIRECTED BY THE CONSTRUCTION MANAGER, TO CREATE A COMPLEX SERIES OF POCKET POOLS THAT EFFECTIVELY DISSIPATE ENERGY AND PROVIDE PATHWAYS FOR FISH MOVEMENT. BOULDER ELEVATIONS SHALL BE ADJUSTED TO ASSURE BOULDER PROTRUSION ABOVE FINISH GRADE IS NO GREATER THAN 0.5-FT.
5. CONTRACTOR SHALL INSTALL CHANNEL SPANNING WOOD (CATEGORY 2 WOOD) AND CHANNEL MARGIN WOOD (CATEGORY 2 WOOD) TO PROVIDE AQUATIC HABITAT COMPLEXITY AND ROUGHNESS. CHANNEL SPANNING WOOD SHALL BE INSTALLED INTO THE BED PERPENDICULAR TO FLOW WITH A MAXIMUM PROJECTION OF 0.3'. CHANNEL MARGIN WOOD SHALL PROJECT NO GREATER THAN 8 FEET INTO THE CONSTRUCTED STREAMBED IN VARIOUS ORIENTATIONS TO FLOW, AS DIRECTED BY CONSTRUCTION MANAGER. CHANNEL MARGIN WOOD SHALL BE EMBEDDED INTO THE CHANNEL STREAMBED A MINIMUM OF ONE-HALF THE LOG DIAMETER, AS SHOWN ON THE DRAWINGS.
6. PREPARE THE MATRIX. AFTER THE FRAMEWORK, WOOD, BOULDER CLUSTERS, AND SMALL BOULDER RIBS ARE INSTALLED AND INSPECTED BY CONSTRUCTION MANAGER, PLACE APPROPRIATE CHANNEL STREAMBED ALLUVIUM GRADATION AND WASH FINES INTO STREAMBED. CHANNEL STREAMED ALLUVIUM SHALL BE PLACED TO THE FULL COURSE THICKNESS OF 12-INCHES TO FINISHED GRADE.

STREAMBED ALLUVIUM GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
6	95	D100
5	90-95	D95
4	85-90	D84
3	65 - 85	D65
2	50 - 65	D50
1	30 - 50	D35
0.5	10 - 30	D15
FINES	0-10	

MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	DIA.	QUANTITY
5	CATEGORY 1 ROCK	12"	0.6 EA
6	CHANNEL STREAMBED ALLUVIUM	6" MINUS	0.3 CY
2	CATEGORY 2 WOOD	3" - 6"	0.08 EA

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

CONSTRUCTED CHANNEL STREAMBED DETAIL

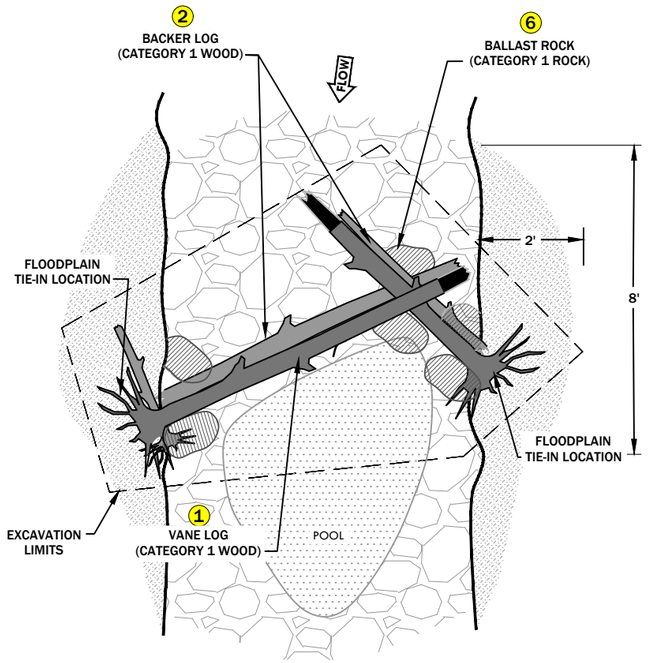
O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

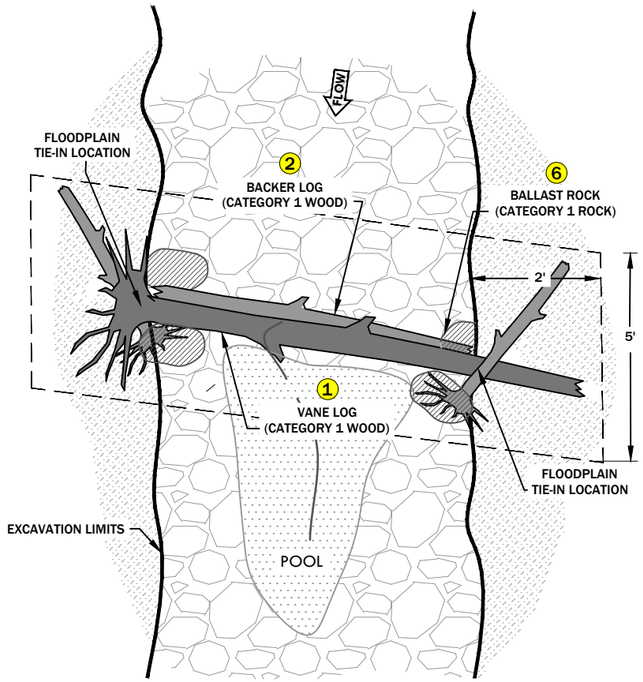
PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
7.2

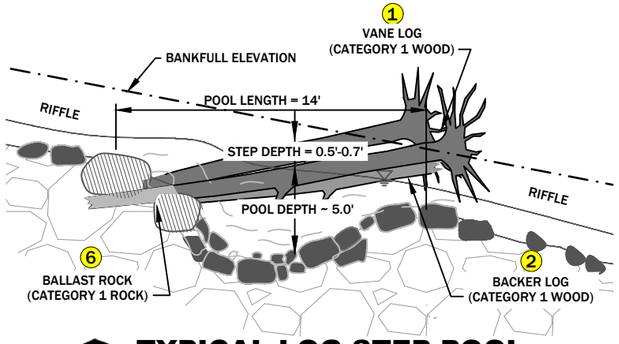
Drawing .2 of 16



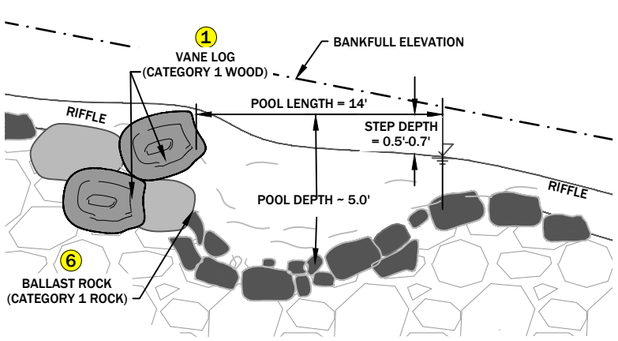
1 TYPICAL LOG STEP POOL PLAN VIEW NTS



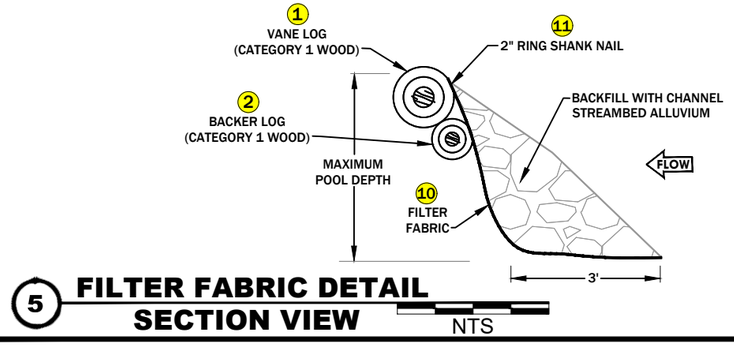
3 TYPICAL LOG STEP POOL PLAN VIEW NTS



2 TYPICAL LOG STEP POOL PROFILE VIEW NTS



4 TYPICAL LOG STEP POOL PROFILE VIEW NTS



5 FILTER FABRIC DETAIL SECTION VIEW NTS

MATERIAL SCHEDULE (PER STRUCTURE)

	ITEM	QUANTITY
1	CATEGORY 1 WOOD	4
2	CATEGORY 2 WOOD	3
6	CATEGORY 1 ROCK	4
10	LF OF FILTER FABRIC	17
11	2" RING SHANK NAILS	20

GENERAL NOTES

1. CONSTRUCTION OF THE CHANNEL LOG STEP POOL WILL OCCUR PRIOR TO THE CONSTRUCTED CHANNEL.
2. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
3. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY ENGINEER.
4. CONTRACTOR SHALL MARK AND ENGINEER SHALL APPROVE THE FLOODPLAIN AND CHANNEL STREAMBED TIE-IN LOCATIONS.

NOTES ON CONSTRUCTED CHANNEL LOG STEP POOL INSTALLATION

1. PRIOR TO CONSTRUCTION OF THE CHANNEL LOG STEP POOL, ENGINEER SHALL VERIFY CHANNEL SUBGRADE ELEVATIONS.
2. CONTRACTOR SHALL STOCKPILE WOOD AND ROCK PER SPECIFICATIONS NOTED ON THE DRAWINGS.
3. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
4. INSTALL VANE LOGS (CATEGORY 1 WOOD) AT THE FLOODPLAIN TIE-IN LOCATIONS AND TO THE ORIENTATIONS NOTED ON THE DRAWING. VANE LOGS SHALL BE PLACED ON CHANNEL ALLUVIUM AND THE ROOTWADS SHALL BE EMBEDDED INTO THE STREAMBANK A MINIMUM OF 2-FT. RELATIVE TO FINISHED BANK LINE.
5. ORIENT VANE LOGS IN CONTACT WITH THE CHANNEL STREAMBED AS SHOWN ON THE DRAWING. EMBED VANE LOG TIPS INTO THE CHANNEL STREAMBED A MINIMUM OF 3-FT. SLOPING AT AN ANGLE NO GREATER THAN 6% RELATIVE TO FLOODPLAIN ELEVATION. VANE LOG TIPS SHALL BE A MINIMUM OF 1-FT. BELOW THE CHANNEL STREAMBED FINISHED GRADE.
6. INSTALL BACKER LOGS (CATEGORY 1 WOOD) ON THE UPSTREAM SIDE OF THE VANE LOGS AS SHOWN ON THE DRAWINGS. BACKER LOGS SHALL BE FLUSH WITH THE VANE LOGS AND EXTEND FROM THE FLOODPLAIN TIE-IN LOCATIONS TO THE TIPS OF THE VANE LOGS.
7. INSTALL CATEGORY 1 ROCK UPSTREAM AND DOWNSTREAM OF THE STREAMBANK TIE-IN LOCATIONS AND VANE LOG TIPS. ROCK SHALL BE IN CONTACT WITH VANE LOGS AND BACKER LOGS TO PROVIDE BALLAST AND TO PREVENT THE STRUCTURE FROM SHIFTING WHILE THE STRUCTURE IS BACKFILLED.
8. ATTACH NON-WOVEN GEOTEXTILE FABRIC TO VANE LOGS AND EXTEND VERTICALLY TO THE MAXIMUM DEPTH OF THE POOL CHANNEL CROSS-SECTION ON THE UPSTREAM SIDE OF THE STRUCTURE, AS SHOWN ON DRAWING. BACKFILL VANE LOGS WITH EXCAVATED CHANNEL STREAMBED ALLUVIUM TO CHANNEL STREAMBED FINISHED GRADE.
9. REGRADE UPSTREAM AND DOWNSTREAM CHANNEL STREAMBED FINISHED GRADE ELEVATIONS. IF EXCESS MATERIAL IS SIDECAST IN POOL DURING CONSTRUCTION, CONTRACTOR SHALL RE-EXCAVATE POOL TO THE DESIGN DIMENSIONS AS APPROVED BY ENGINEER.

EXAMPLE OF A CONSTRUCTED LOG STEP POOL

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

CHANNEL LOG STEP POOL

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

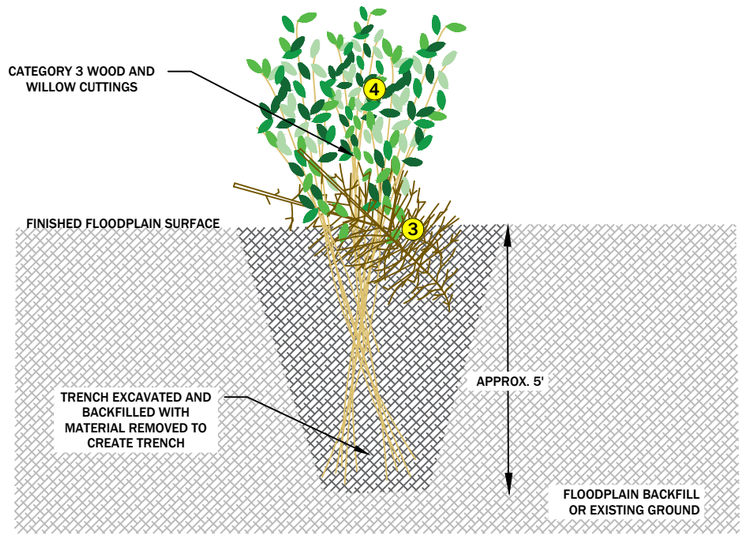
NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
7.3

Drawing .3 of 16

\\rdg\wt\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg



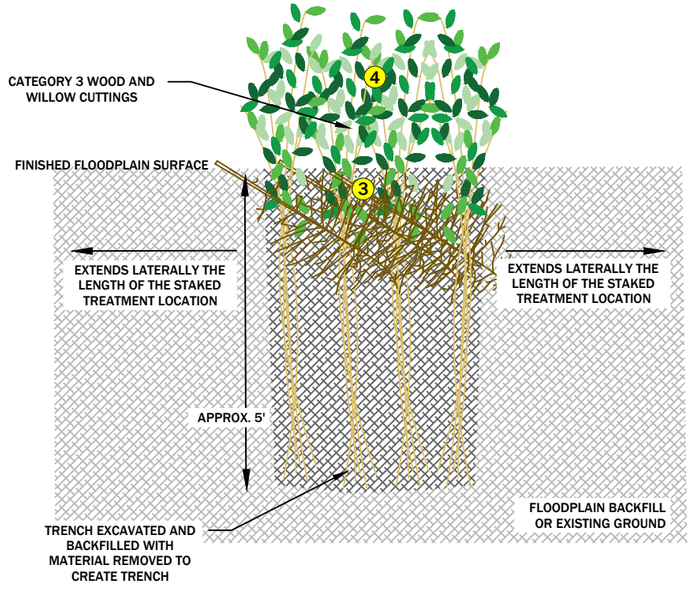
1 VEGETATED BRUSH TRENCH PROFILE VIEW NTS

GENERAL NOTES

1. VEGETATED BRUSH TRENCHES WILL BE CONSTRUCTED TO INCREASE FLOODPLAIN CONNECTIVITY, DISPERSE SURFACE FLOWS AND PROMOTE REVEGETATION. CONSTRUCTION OF VEGETATED BRUSH TRENCHES WILL OCCUR AFTER SEPTEMBER 15TH AND BEFORE THE END OF THE CONSTRUCTION SEASON.
2. CONTRACTOR SHALL MARK AND ENGINEER SHALL APPROVE THE GENERAL CONSTRUCTION LOCATION FOR EACH VEGETATED BRUSH TRENCH PRIOR TO CONSTRUCTION.

NOTES ON VEGETATED BRUSH TRENCH INSTALLATION

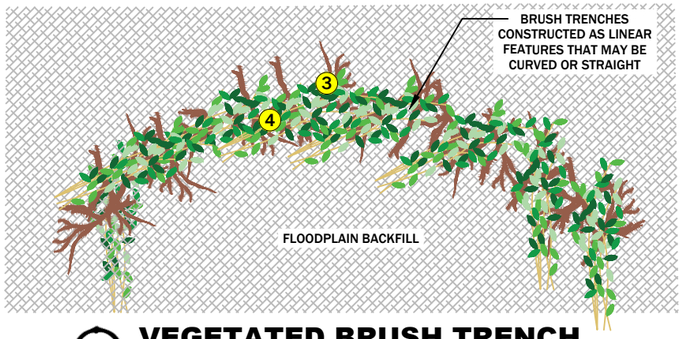
1. VEGETATED BRUSH TRENCHES WILL BE CONSTRUCTED WITHIN THE FLOODPLAIN AT THE DIRECTION OF THE CONSTRUCTION MANAGER.
2. A TRENCH WILL BE CONSTRUCTED APPROXIMATELY 5' DEEP AND EXTEND THE LENGTH OF THE STAKED TREATMENT LOCATION. LIVE WILLOW CUTTINGS AND CATEGORY 3 WOOD WILL BE PLACED IN THE TRENCH SUCH 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.



2 VEGETATED BRUSH TRENCH SECTION VIEW NTS

MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	DIA.	QUANTITY
3	CATEGORY 3 WOOD	< 3"	2
4	WILLOW CUTTINGS	0.25" - 1"	5



3 VEGETATED BRUSH TRENCH PLAN VIEW NTS

EXAMPLE OF A VEGETATED BRUSH TRENCH INSTALLATION

EXAMPLE OF A CONSTRUCTED VEGETATED BRUSH TRENCH

RDG RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

VEGETATED BRUSH TRENCH DETAIL

O'BRIEN CREEK RESTORATION PROJECT
MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
7.4

Drawing .4 of 16

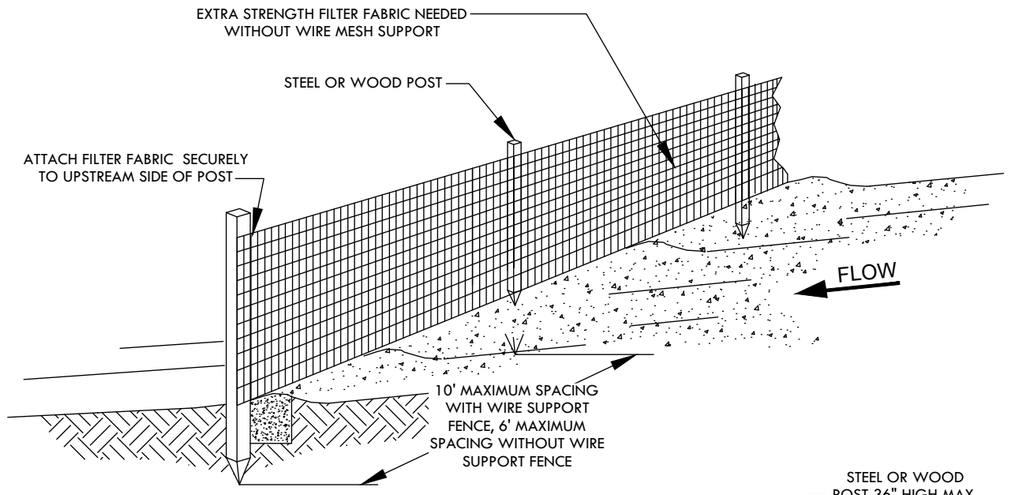
\\rdgfs\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

SEDIMENT FENCE GENERAL NOTES

1. THE HEIGHT OF A SEDIMENT FENCE SHALL NOT EXCEED 36 INCHES. STORAGE HEIGHT AND PONDING HEIGHT SHALL NEVER EXCEED 18 INCHES.
2. THE FENCE LINE SHALL FOLLOW THE CONTOUR AS CLOSELY AS POSSIBLE.
3. IF POSSIBLE, THE FILTER FABRIC SHALL BE CUT FROM A CONTINUOUS ROLL TO AVOID THE USE OF JOINTS. WHEN JOINTS ARE NECESSARY, FILTER CLOTH SHALL BE SPLICED ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP AND BOTH ENDS SECURELY FASTENED TO THE POST.
4. POSTS SHALL BE SPACED A MAXIMUM OF 10 FEET APART AND DRIVEN SECURELY INTO THE GROUND (MINIMUM OF 12 INCHES. WHEN EXTRA-STRENGTH FABRIC IS USED WITHOUT THE WIRE SUPPORT FENCE, POST SPACING SHALL NOT EXCEED 6 FEET.
5. TURN THE ENDS OF THE FENCE UPHILL.
6. A TRENCH SHALL BE EXCAVATED APPROXIMATELY 4 INCHES WIDE AND 6 INCHES DEEP ALONG THE LINE OF POSTS AND UPSLOPE FROM THE BARRIER.
7. WHEN STANDARD-STRENGTH FILTER FABRIC IS USED, A WIRE MESH SUPPORT FENCE SHALL BE FASTENED SECURELY TO THE UPSLOPE SIDE OF THE POSTS USING HEAVY DUTY WIRE STAPLES AT LEAST 1INCH LONG, TIE WIRES OR HOG RINGS. THE WIRE SHALL EXTEND INTO THE TRENCH A MINIMUM OF 2 INCHES AND SHALL NOT EXTEND MORE THAN 36 INCHES ABOVE THE ORIGINAL GROUND SURFACE.
8. THE STANDARD-STRENGTH FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE FENCE, AND 6 INCHES OF THE FABRIC SHALL EXTEND INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 36 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO EXISTING TREES.
9. WHEN EXTRA-STRENGTH FILTER FABRIC AND CLOSER POST SPACING ARE USED, THE WIRE MESH SUPPORT FENCE MAY BE ELIMINATED. IN SUCH A CASE, THE FILTER FABRIC IS STAPLED OR WIRED DIRECTLY TO THE POSTS.
10. THE TRENCH SHALL BE BACKFILLED AND THE SOIL COMPACTED OVER THE TOE OF THE FILTER FABRIC.
11. SEDIMENT FENCES PLACED AT THE TOE OF A SLOPE SHALL BE SET AT LEAST 6 FEET FROM THE TOE IN ORDER TO INCREASE PONDING VOLUME.
12. SEDIMENT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED AND ANY SEDIMENT STORED BEHIND THE SEDIMENT FENCE HAS BEEN REMOVED.

INSPECTION AND MAINTENANCE:

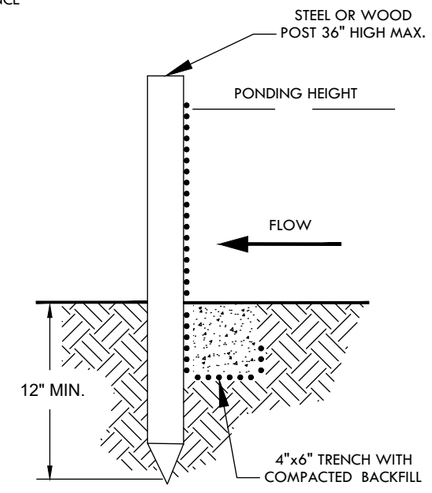
1. SEDIMENT FENCES AND FILTER BARRIERS SHALL BE INSPECTED WEEKLY AFTER EACH SIGNIFICANT STORM (0.25 INCH IN 24 HOUR). ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
2. SEDIMENT SHOULD BE REMOVED WHEN IT REACHES 1/3 HEIGHT OF THE FENCE OR 9 INCHES MAXIMUM.
3. THE REMOVED SEDIMENT SHALL CONFORM WITH THE EXISTING GRADE AND BE VEGETATED OR OTHERWISE STABILIZED.



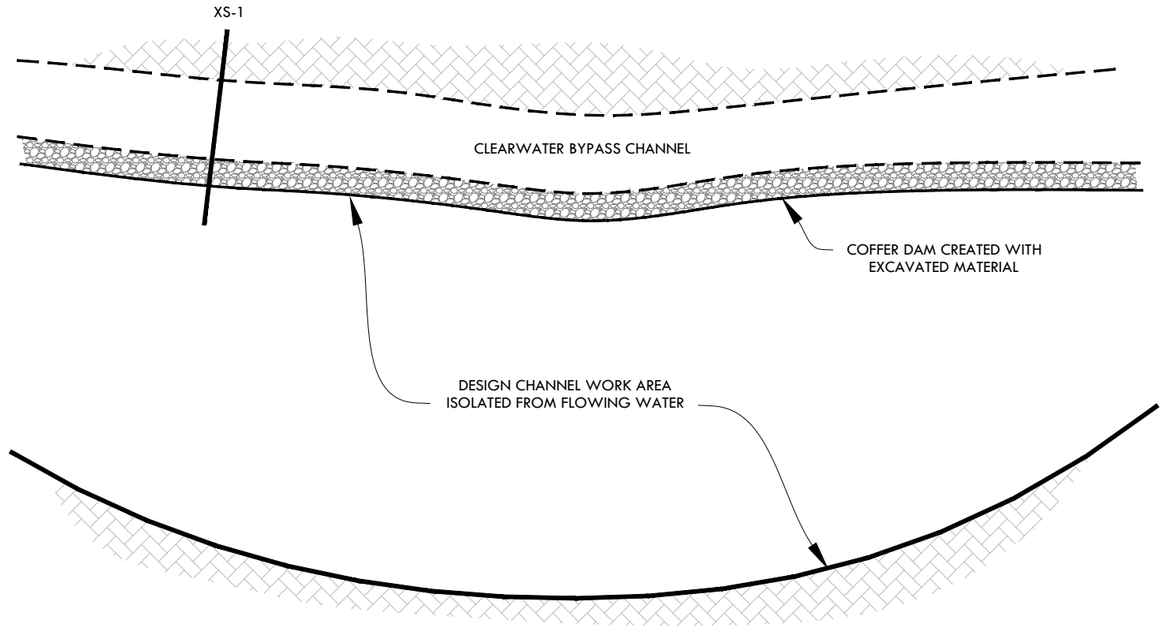
SEDIMENT FENCE DETAIL NTS

ADDITIONAL NOTES:

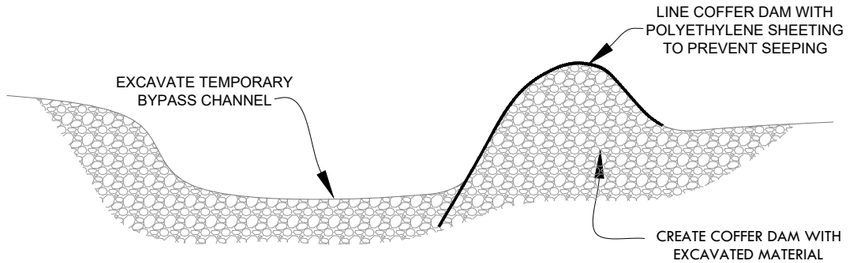
1. SEDIMENT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. 9" MAXIMUM RECOMMENDED STORAGE HEIGHT.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.



TRENCH DETAIL



TEMPORARY COFFER DAM DETAIL
PLAN VIEW NTS



TEMPORARY COFFER DAM DETAIL
XS-1 NTS

RDG
RIVER DESIGN GROUP
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920
236 Wisconsin Avenue
Whitefish, MT 59937
406.862.4927

BMP DETAILS

O'BRIEN CREEK RESTORATION PROJECT

MISSOULA, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
*	10/20/21	NW	PRELIMINARY DESIGN	JM

PROJECT NUMBER
RDG-21-169

DRAWING NUMBER
7.5

Drawing .5 of 16

\\rdg\fs\Projects\2021\RDG-21-169 OBrien Creek - CFC\CAD\2021-10-11 Obrien Working.dwg

Supplemental Information

PRELIMINARY DESIGN COST ESTIMATE

11/9/2021

O'BRIEN CREEK CONSTRUCTION COST ESTIMATE

RDG COST ESTIMATE

BID ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	MOBILIZATION, GPS EQUIPMENT, CREW PER DIEM	1	LS	$9,000.00	$9,000.00
2	CLEARWATER DIVERSION, WATER CONTROL, BMPs	1	EA	$2,500.00	$2,500.00
3	FURNISH ALLUVIUM	175	CY	$20.00	$3,500.00
4	FURNISH WOOD AND BRUSH	1	LS	$10,000.00	$10,000.00
5	EXCAVATE, HAUL, AND PLACE MATERIAL	705	CY	$5.00	$3,525.00
6	EXCAVATE, AND HAUL	800	CY	$10.00	$8,000.00
7	CONSTRUCT CHANNEL STREAMBED	575	LF	$23.00	$13,225.00
8	CONSTRUCT LARGE WOOD STRUCTURES	9	EA	$700.00	$6,300.00
9	CONSTRUCT LOG STEP POOL STRUCTURES	7	EA	$500.00	$3,500.00
10	CONSTRUCT VEGETATED WOOD MATRIX TYPE 1 (RIFFLES)	930	LF	$13.00	$12,090.00
11	CONSTRUCT VEGETATED WOOD MATRIX TYPE 2 (TRANSISTIONS)	500	LF	$18.00	$9,000.00
12	CONSTRUCT VEGETATED WOOD MATRIX TYPE 3 (POINT BARS)	300	LF	$5.00	$1,500.00
13	FURNISH WILLOW CUTTINGS	10,350	EA	$1.00	$10,350.00
14	BLACK COTTONWOOD TREE - 5 GALLON POTTED	24	EA	$55.00	$1,320.00
	SUBTOTAL CONSTRUCTION				**$93,810.00**
14	SURVEY CONTROL, GPS SITE CALIBRATION	1.0	LS	$3,000.00	$3,000.00
15	CONSTRUCTION MANAGEMENT AND DIRECT COSTS	1.0	LS	$9,381.00	$9,381.00
	SUBTOTAL CONSTRUCTION MANAGEMENT				**$12,381.00**
	CONTINGENCY				$9,381.00
	TOTAL COST				**$115,572.00**

AC = Acres EA = Each SY = Square Yards Kgal = 1,000 Gallons
CY = Cubic Yards LF = Linear Feet LS = Lump Sum

COOPERATIVE AGREEMENT
between
Clark Fork Coalition
and
O'Brien Creek Meadows HOA (Landowner)

This Cooperative AGREEMENT, dated as of August 4, 2021 (the "Effective Date") is entered into between the Clark Fork Coalition, a Montana nonprofit corporation, at 140 S. 4th Street West, Unit 1, Missoula, MT 59801 ("CFC"), and the O'Brien Creek Meadows Home Owners Association, PO Box 3502, Missoula, MT 59806("Landowner"). CFC and Landowner are sometimes referred to collectively herein as the "PARTIES." In consideration of the mutual covenants and stipulations described below, CFC and the Landowner agree as follows:

1. PURPOSE AND GENERAL PROJECT DESCRIPTION: The purpose of this Agreement is for the Clark Fork Coalition and the Landowner to agree on restoration work to be performed by the Coalition on O'Brien Creek on Landowner's property (the "Project"). The Project will include work on or near Landowner's communal property, located generally south of O'Brien Creek Road, in the S2S2 of Section 27, and the N2N2 of Section 34, both in Twp 13N, Rge 20W in Missoula County. CFC and Landowner have the mutual desire to cooperate in carrying out the activities contemplated herein and this Agreement sets forth the obligations of both CFC and Landowner.

2. BACKGROUND AND SCOPE OF WORK: In 2019, a stream bank failure into O'Brien Creek resulted in deposition of sediment into the channel and floodplain of the O'Brien Creek Meadows HOA's common area (i.e. the Project area). In 2019, CFC oversaw emergency actions taken to remove the substrate deposition in the main channel and return wood into the stream channel (Phase 1). This Agreement will allow CFC to implement Phase 2 of the Project to rehabilitate the stream channel, improve stream function and enhance the ecological function of the stream and adjacent riparian area. Phase 2 will include increasing stream sinuosity, raising channel profile access to the floodplain, adding log step pools, re-aligning the channel into existing channels to avoid road fill erosion, and revegetating the riparian area. The Scope of Work for CFC is further described in the Project Plan Set attached as Exh. A.

3. PERIOD OF PERFORMANCE: This Agreement shall begin on the Signing Date of this Agreement and terminate on December 31, 2041. All work described in the Scope of Work except for post-project monitoring will take place between July, 2022 and December, 2022.

4. COST OF THE PROJECT: As consideration for Landowner's consent under this Agreement, the CFC will raise funds and pay for all costs for the Project. Landowner may contribute funding toward the Project, but CFC's responsibilities under this Agreement are not contingent upon the receipt of such funds from the Landowner.

5. CFC'S RESPONSIBILITIES: CFC, its employees, agents, and agency partners shall:

a. Provide technical support, all monetary funding and in-kind support for the Project (as described in Scope of Work and Cost of Project);

b. Provide oversight of the Project, including but not limited to grant writing, acquisition of necessary permits, Project coordination, management and oversight of construction activities and all other activities related to the Project;

c. Perform long-term monitoring of the Project;

d. Provide prompt notice to Landowner of any specific areas of concern related to the Project, and repair or replace Project improvements should they become endangered, change or destroyed through natural means; and

e. Prepare any and all reports.

6. LANDOWNER'S RESPONSIBILITIES: Landowner, its employees, and agents shall:

f. Guarantee ownership of the above-described lands and warrant that there are no outstanding rights that will interfere with this cooperative Agreement;

g. Allow for and maintain a minimum riparian buffer of 25-feet as measured horizontally from the ordinary high-water mark;

h. Use reasonable efforts to protect the restoration improvements and, except in cases of emergency or Force Majeure as described in paragraph 10, refrain from removing or impeding the restoration investments for a minimum of 20 years following completion of the Project.

i. Allow access for post-treatment monitoring for the life of the agreement.

7. AGREEMENT CONDITIONED ON FUNDING: Landowner acknowledges that funding for the Project is dependent upon availability of state, federal, and non-federal funds subject to circumstances beyond the control of CFC. CFC shall not be liable for failure to provide funds committed to the Project if those funds have been withheld for events or circumstances beyond the control of CFC. However, if funding fails, CFC shall release Landowner from its obligations under this Agreement.

8. COOPERATION AND ACCESS: The Parties shall cooperate as needed in the performance of the Scope of Work. Landowner shall give unrestricted access to CFC for the Project site as needed for CFC to perform its obligations under this Agreement, including any required inspections. CFC will give 24-hour notice to Landowner of any required visits.

9. FORCES BEYOND THE CONTROL OF THE PARTIES: Neither party shall be liable to the other party, nor deemed to be in breach of this Agreement, for failure or delay in performance arising from a Force Majeure. Force Majeure means an event beyond the reasonable control of the affected party, and which the party is unable to prevent or provide against by exercising reasonable diligence. If Landowner fails to meet terms of the Agreement due to circumstances beyond its control, Landowner shall release CFC from its obligations under this Agreement. If CFC fails to meet terms of the Agreement due to circumstances beyond its control, CFC shall release Landowner from its obligations under this Agreement.

10. INDEMNITY: CFC agrees to indemnify and hold harmless the Landowner for any damages, loss or injuries incurred during the Project, except for damages and injuries caused by willful misconduct or gross negligence of the Landowner. CFC shall maintain its general liability policy for bodily injury, death or loss, or damage to property of third persons or other liability in the minimum amount of $1,000,000 per occurrence and $2,000,000 in the aggregate. In addition, both CFC and Landowner shall be named as additional insured parties on the Project Contractor's general liability policy bodily injury, death or loss, or damage to property of third persons or other liability in the minimum amount of $1,000,000 per occurrence and $2,000,000 in the aggregate.

11. ASSIGNMENT AND DELEGATION: The provisions of this Agreement shall be binding upon the heirs, personal representatives, administrators, successors and assigns of the parties in like manner as upon the original parties. This Agreement may not be assigned without the express, written consent of the parties.

12. AMENDMENT: This Agreement may be modified at any time by mutual written consent of Landowner and CFC. No other communication between the parties shall modify or be part of this Agreement except by express written consent. This Agreement may be terminated in writing by either party with thirty (30) days notice.

13. TERMINATION: This Agreement may be terminated in writing by either party by providing thirty (30) days advance notice. If Landowner terminates this Agreement, fails to comply with terms and conditions of this Agreement, fails to respond to reasonable requests from CFC to take corrective actions, or the restoration site is degraded due to purposeful or negligent activities of the Landowner, Landowner shall reimburse CFC for the cost of the habitat developments on a pro rata basis.

14. GOVERNING LAW: The law of the State of Montana governs this Agreement.

15. ATTORNEY'S FEES AND COSTS: If a suit, action or arbitration is instituted in connection with any controversy arising out of this Agreement or to enforce any rights hereunder, the prevailing party shall be entitled to recover such amount as the court may adjudge reasonable as attorneys' or paralegals' fees at trial or on any appeal or review, in addition to all other amounts provided by law.

16. PRINCIPAL CONTACTS:

CFC is exclusively responsible for all management aspects of this Project. The principal contacts for this Agreement are:

CFC Project/Contract Officer:
Adam Switalski
Clark Fork Coalition
PO Box 7593
Missoula, MT 59807
Tel. 406-396-1941
Email: Adam@clarkfork.org

Landowner
Bill Darling, HOA President
O'Brien Creek Meadows HOA
PO Box 3502
Missoula, MT 59806
Tel. 406-360-3327
Email: w.r.darling@hotmail.com

CLARK FORK COALITION

Karen Knudsen Date:
Executive Director

O'BRIEN CREEK MEADOWS HOA

Bill Darling Date: 8.4.21
HOA President

O’brien Creek Spring 2019 Photos

Large cut bank at the top of Reach 3

O’brien Creek left it’s banks spring of 2019 and flooded large areas due to massive sediment aggradation

Out migrating spawning Westslope Cutthroat trout stranded due to large sediment plug choking creek

Project 2

2022 319 Application Form - Supplemental Project Form

**********REVISED 10/22/2021**********

Project Name	Miller and O'Brien Creeks Sediment Reduction and Restoration

A separate Project Form ***(including providing separate attachments)*** must be submitted for each project included in your application. Use the following examples to help determine when to lump and when to split projects. For additional assistance, contact Mark Ockey at mockey@mt.gov or 406-465-0039.

Splitting Examples (fill out multiple Project Forms)

- Stream restoration work occurring on two separate streams, on parcels owned by two separate individuals
- Two projects with significantly different sets of project partners
- Two projects that address substantially different pollution sources (e.g., one project moves a corral off of a streambank, and another removes mine tailings, with both projects being on the same property)

Lumping Examples

- Contiguous stream restoration work spanning multiple land parcels
- 3 projects that address similar sources of pollution on a single land parcel (e.g., moving a corral off a stream, implementing a grazing management plan, and relocating a manure storage facility out of the floodplain, all on the same ranch)

Project Name	Upper O'Brien Creek Stream Restoration

Select the watershed restoration plan (WRP) that your project will help implement.

Bitterroot - Bitter Root Water Forum

N — Letter of support from author entity attached? *(If no, explain why below.)*

Because the Clark Fork Coalition (CFC), with support of the Lolo National Forest, wrote the WRP for O'Brien Creek we felt it redundant and somewhat awkward to submit a letter from the authors in support of our own proposal. We'd be happy to provide a letter from the CFC, if it would assist these efforts. We do have substantive support letters attached from other relevant stakeholders.

Waterbody name from 2020 List of Impaired Waters	Bitterroot River
Probable causes of impairment to be addressed	Temperature
Waterbody name from 2020 List of Impaired Waters	
Probable causes of impairment to be addressed	

OR*

Name of healthy waterbody to be protected	O'Brien Creek
Description of identified threat to non-impairment status	This stream has not been assessed by the DEQ yet, however, identified threats include sediment / siltation and alteration in stream-side vegetative cover
Name of healthy waterbody to be protected	Bitterroot River
Description of identified threat to non-impairment status	Recently de-listed for sediment / siltation

**While the majority of the available 319 project funding is dedicated to addressing known impairments, EPA is allowing states to use a limited amount of funding to protect non-impaired waters (healthy waters) from becoming impaired.*

Project Location

Upstream End	Latitude	46.849590	Longitude	-114.212898
Downstream End	Latitude	46.850273	Longitude	-114.186882
Centerpoint	Latitude	46.848179	Longitude	-114.199753

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

List the 12-digit Hydrologic Unit Code(s) (HUCs) in which the project area is located: 170102051502

☑ Project site map(s) attached, showing the location of all proposed on-the-grount restoration activities?

Community Participation and Support

Landowner	Contributions to Project	Letter of Support Attached?
USDA Forest Service	In fall 2019, a survey was conducted by the Forest Service to determine O'Brien Creek stream conditions and impacts of the road system. Drafted report.	☑
		☐
		☐
		☐

Partner	Role	Letter of Support Attached?
WestSlope Chapter of Trout Unlimited	Supportive of project and providing matching funds	☑
Missoula Valley Water Quality District	Project supporter, monitors water quality on O'Brien Creek	☑
		☐
		☐

Other Community/Stakeholder Support

Montana Fish Wildlife and Parks is supportive of the project, supportive of project, providing matching funds through Future Fisheries Program, and monitors the fishery. However, due to recent policy changes, Biologists are not allowed to provide letters of support for restoration projects.

Project Description

Describe the nature and extent of the nonpoint source problem you are trying to address, the root causes of the problem, and your proposed solution.

Our project proposes to reduce a nonpoint source in the Bitterroot Focus Watershed on the 25.4-square-mile O'Brien Creek watershed in Missoula County. This watershed is in the lower section of the Bitterroot basin and land ownership along the creek includes public ownership on U.S. Forest Service land in the upper and headwaters reaches, and private parcels of various sizes in the lower watershed and valley bottom.

O'Brien Creek has experienced extensive human uses for more than a century, including a railroad in the valley bottom for timber extraction, extensive road development and timber harvest in the uplands, severe manipulation from ditching and irrigation withdrawals, a grain mill at the confluence with the Bitterroot, among others uses. These historic uses of the watershed have resulted in several sources of nonpoint pollution along the O'Brien Creek. The Bitterroot Watershed Restoration Plan (2020) and Forest Service stream and road surveys (2019) have identified several current sources of nonpoint pollution in O'Brien Creek.

A primary nonpoint source problem in the upper O'Brien Creek are Forest Service roads with significant active road and road fill erosion including a large road fill failure (see attached photos). While some roads in the watershed have been decommissioned, currently there is a high road density in the watershed (5.17 mi/mi2) including 6.2 miles of the O'Brien Creek Road along 10.3 miles of its mainstem. In fact, 60% of the road is within 200 ft. of the stream. Additionally, portions of the old railroad grade runs alongside the road delivering sediment into the stream where it is slumping into the creek.

In addition to road-associated impacts, the stream is entrenched and incised. Channel entrenchment limits floodplain connectivity in most of the reach. Several bank failures are also chronically delivering sediment into the stream. Aquatic habitat is mostly riffle habitat features with little in-stream wood and limited pools. The combination of these multiple nonpoint pollution sources produce sediment at levels high enough to smother fish spawning redds and macroinvertebrate habitat.

The Clark Fork Coalition (CFC) proposes to address nonpoint sediment issues on upper O'Brien Creek by working closely with the Forest Service to reduce sediment loading, restore stream and floodplain function, and improve in-stream wildlife habitat. The project is focused on a 1.5 mile highest-priority section of the creek where the stream is entrenched, has little in-stream wood, and is producing sediment from encroaching into road fills and eroding banks. The Forest Service will provide technical assistance and matching funds.

We are seeking funds for design and implementation of the following restoration strategies in the project area to address the root causes of the problem:

- Evaluate opportunities to move stream-side road
- Evaluate opportunities to reconnect former floodplain surfaces by slightly raising the channel profile
- Reduce road-stream channel interactions through channel re-location
- Where channel re-location is not possible, stabilize banks and road fillslope failures to reduce sediment inputs to the channel
- Increase the frequency and quality of pools throughout the reach with wood installation

Is this project a continuation of a previous project? If so, please explain the connection.

Yes, the Clark Fork Coalition has been actively working to restore O'Brien Creek for over 17 years now starting with an instream flow lease to reconnect the dewatered lower reaches of the creek in 2004. In 2014 CFC permanently acquired 3.6 cfs of water and entered a 10 year lease for an additional 1.2 cfs. These water rights protect all the available water in the creek from it's headwaters to the confluence with the Bitterroot during the critical low flow months. In addition to CFC's work in the watershed, the Lolo NF has completed large scale road decommissioning in the headwaters, and MT FWP completed channel restoration at the mouth.

This project addresses the highest priority problems identified in a DEQ Project Development Grant for O'Brien Creek (2021) including a Forest Service road survey and stream assessment in 2019. This work will also compliment planned stream restoration work on private lands downstream in the O'Brien Creek Meadows to re-naturalize the stream channel on a problematic reach of Lower O'Brien Creek. This project will restore approximately 2,000 ft. that experienced a massive bank failure in 2019 which led to deposition and instability in the lower reaches.

Water Quality Benefits and Sustainability

Explain why the project is an appropriate next step for making progress towards removing a pollutant/waterbody combination from Montana's 2018 Impaired Waters List or preventing a healthy waterbody from becoming impaired?

This is an appropriate next step for keeping O'Brien Creek and the Lower Bitterroot off the impaired waters list for sediment because the 1.5 mile project reach was identified as the highest source of eroding banks and road sediment delivery of all the study reaches in the O'Brien Creek assessment. This 1.5 mile reach was found to be incised / entrenched, have eroding banks, and have chronic road-associated erosion that are adding to an excess sediment load. In particular, a large road fill failure at the Forest Service boundary has been identified as a major contributor of sediment to the system "refer to attached photos." Addressing nonpoint sediment sources on Forest Service lands will compliment additional efforts to reduce nonpoint sediment downstream on private lands, and past Clark Fork Coalition efforts to restore flow in O'Brien Creek.

Will your project address a major local source of nonpoint source pollution? Explain.

Yes, this project will address a major local source of nonpoint pollution including extensive bank erosion and road-associated erosion. The 2019 Forest Service assessment, which included middle O'Brien Creek mainstem, found that O'Brien Creek is adding large amounts of sediment to the Lower Bitterroot River, where millions of dollars have already been invested to protect from nonpoint source pollution.

Will the project create long-term, sustainable reductions in NPS pollution? Explain.

Yes, this project will create long-term, sustainable reductions in NPS pollution because we will be fixing the eroding banks and road-associated erosion along the creek. The O'Brien Creek Road runs very close to the creek in this reach, and out project would move the stream away from the closest sections of the road, and/or stabilize the road fill. Additionally, erosive banks would be stabilized and revegetated. The addition of wood would also store sediment, increase pools, and improve aquatic habitat complexity benefiting fish and other aquatic organisms for the long term. For example, monitoring from Montana Fish Wildlife and Parks has found that the addition of wood into streams has resulted in a 2-3 fold increase in fish populations (Ladd Knotek pers. comm.).

Describe how the project will promote self-maintaining, natural, ecological and social processes that protect water quality?

The goal of this project is to restore and promote self-maintaining, natural, and ecological processes to upper O'Brien Creek. Much of the creek's sediment issues originated from unnatural processes, such as historical road and railroad construction to access timber extraction on Forest Service lands. Our proposed treatments will help return the creek to a more natural state by re-connecting the floodplain in entrenched segments, stabilizing road and railroad fills, and replacing removed wood for sediment storage, energy dissipation and recovery of fisheries habitat.

Nonpoint Source Goals and Success Metrics

Nonpoint source pollution goal	Action that will be taken to reach the goal	Metrics used to measure success
O'Brien Creek: - Reduce tons / yr of sediment generated by unpaved parallel road segments (currently 11.98 tons/yr - From Bitterroot WRP).	-Reduce road-stream channel interactions through channel re-location (or moving road) -Stabilize road fillslope failures to reduce sediment inputs to the channel.	Reductions in tons/yr of sediment measured through WEPP modeling. Success of re-vegetation measured through photo-points.
O'Brien Creek: -Reduce tons / yr sediment delivery from stream bank erosion (currently 1-2 orders of magnitude above natural levels - From Bitterroot WRP).	-Treat streambank erosion to reduce sediment inputs to the channel. -Increase sediment storage, the frequency of pools, and aquatic habitat complexuty with wood installation -Reconnect former floodplain surfaces by slightly raising the channel profile	Reductions in tons/yr of sediment measured through BEHI surveys. Increased number of instream wood and pools Success of re-vegetation measured through photo-points.

Project Education and Outreach

Describe the educational benefits of your project. Will the project inspire additional nonpoint source pollution prevention work within the watershed?

This project has many educational benefits and will inspire additional work in the watershed. Effective nonpoint source pollution management relies on clear and consistent education and outreach that raises awareness about nonpoint source issues and widespread best management practice implementation that motivates others to act. We plan to share the results and lessons learned with other landowners and stakeholders as a catalyst for continuing restoration projects on other TMDL listed streams in the Clark Fork River basin. These projects boost the ecological health of familiar, backyard streams and demonstrate the power of collaboration when NGOs work with natural resource agencies work together. We believe that will be the case here too, especially when accompanied by personal outreach, tours, reports, and media stories.

Bigger Picture Benefits

NPS pollution projects often have benefits that go beyond simply cleaning up Montana's lakes and streams. Describe your project's benefits to each of the items below. If there are no associated benefits, type "NA" for "not applicable".

Environmental Justice (EJ)

Will the project improve or create public access to a healthy environment?

Yes, this project will maintain public access to a healthy environment. One of the key objectives of this project is to mitigate the O'Brien Creek Road which is actively eroding and falling into the creek. Stabilizing the road, and preventing a complete road wash out will allow access to continue into the watershed - both for management by the Forest Service and for recreation by the public. Additionally, by reducing the source of sediment to the creek and improving stream conditions, this project, coupled with potential future projects, can provide substantive improvements to the overall health of both the Bitterroot and Clark Fork River fishery, stream conditions, and water quality.

Will the project have a public benefit in a county where 15% or more of the population lives below the poverty level? Counties include: Big Horn, Blaine, Chouteau, Deer Lodge, Garfield, Glacier, Golden Valley, Hill, Lake, Liberty, Lincoln, Meagher, Mineral, Musselshell, Pondera, Powell, Roosevelt, Rosebud, Sanders, Silver Bow, Toole and Wheatland.

No, this project is in Missoula County

Will the project benefit historically underserved populations (e.g. minority populations, people with disabilities)?

Yes, the project will benefit historically underserved populations. The O'Brien Creek Road has catastrophically failed and is actively eroding into the creek at the beginning of Forest Service lands, but is still largely accessible to all users. If the road continues to fail to the point that vehicular access is prohibited, access to that public land for people with mobility disabilities would be limited. Stabilizing the streambank at this location will ensure access will continue into the watershed for all users.

Climate Change

Will the project improve climate change resilience for communities, native plants, wildlife or ecosystems?

Yes, this project will improve climate change resilience for downstream communities by reducing sediment delivery into streams and improving water quality. Native plants and animals will also benefit in the face of climate change. With more stable banks, native vegetation can recolonize streambanks devoid of vegetation. Additionally, O'Brien Creek is a very cold creek and Forest Service modeling has determined that the creek provides a climate refuge for westslope cutthroat trout. Restoring more natural levels of stream sediment will improve spawning grounds and increase the resilience of west slope cutthroat trout and other aquatic organisms in the face of climate. Our proposal affords greater channel resiliency towards fluctuations in both flooding and drought conditions.

Will the project restore or protect cool, late-season flow?

Yes, the project will lead to more connectivity to floodplains and wetlands, a proven method for recharging ground water and contributing to late season flows.

Impacts to Downstream Communities

Will the project reduce pollutant loading above a permitted point source discharge in a way that could increase assimilative capacity in the the receiving water?

This project will reduce sediment pollution loading, however, there are not any known permitted point source discharges downstream.

Will the project help protect a drinking water source?

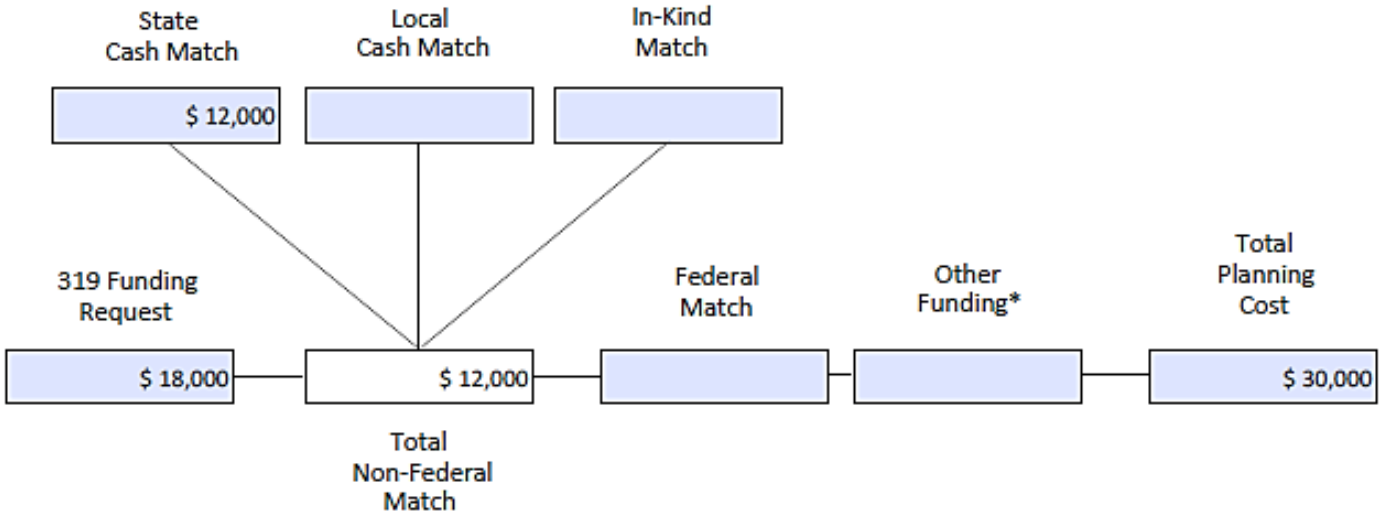
This project does not involve protecting drinking water.

Tasks and Budget

DEQ uses a standard template to develop scopes of work for 319 contracts. The tasks below match up with DEQ standard scope of work template. Some tasks might not be applicable to your project. Please leave the non-applicable tasks blank. If your project doesn't fit the task outline, use the task labeled "Other" to describe your project.

Task 1 - Project Planning Deliverables *(Include such things as completing project designs, conducting site evaluations, obtaining permits, organizing volunteers, conducting scoping meetings, etc. Identify specific deliverables that will be submitted.)*

Contractor shall submit to DEQ the following deliverables:
- A complete, draft copy of project designs for review and comment.
- A complete, final copy of project designs. In the final designs, Contractor shall address all concerns raised by DEQ in the review of previous drafts.
- A complete, detailed cost estimate for implementation of the final designs, and a list of potential funding sources for implementation.
- A list of all permits and authorizations necessary for implementation.
- Documentation of the landowners' acceptance and approval of the final designs.



Match Source	Future Fisheries	Secured	
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

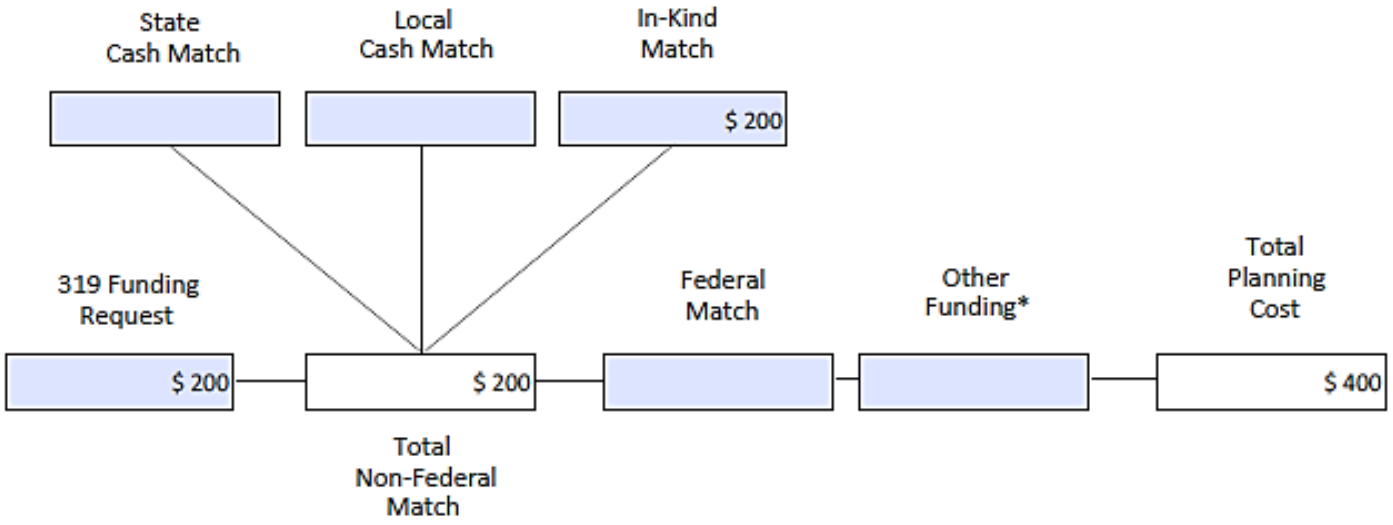
**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Landowner Agreements, Operation and Maintenance

This task only applies to projects involving on-the-ground activities. DEQ periodically evaluates the effectiveness of each on-the-ground project. To accomplish this, DEQ requires a process be in place to allow periodic access to the project site. The landowner agreement should also specify the roles of each project partner in the design, implementation and continued operation of on-the-ground pollution prevention practices. DEQ does not require the use of a specific landowner agreement template. In some situations, existing agreements between the project sponsor and the landowner may be sufficient.

Task 2 - Landowner Agreements, Operation and Maintenance Deliverables *(Include such things as landowner/ sponsor communication, and draft and final agreements.*

Contractor will submit to DEQ the following deliverables:
• Draft landowner agreements for review and comment, in Microsoft Word or pdf format. Contractor will submit all draft landowner agreements prior to signature, and allow sufficient time for review, comment, and subsequent modification prior to implementation.
• PDF copies of signed landowner agreements. Contractor will ensure signed landowner agreements address all comments and concerns raised by DEQ.



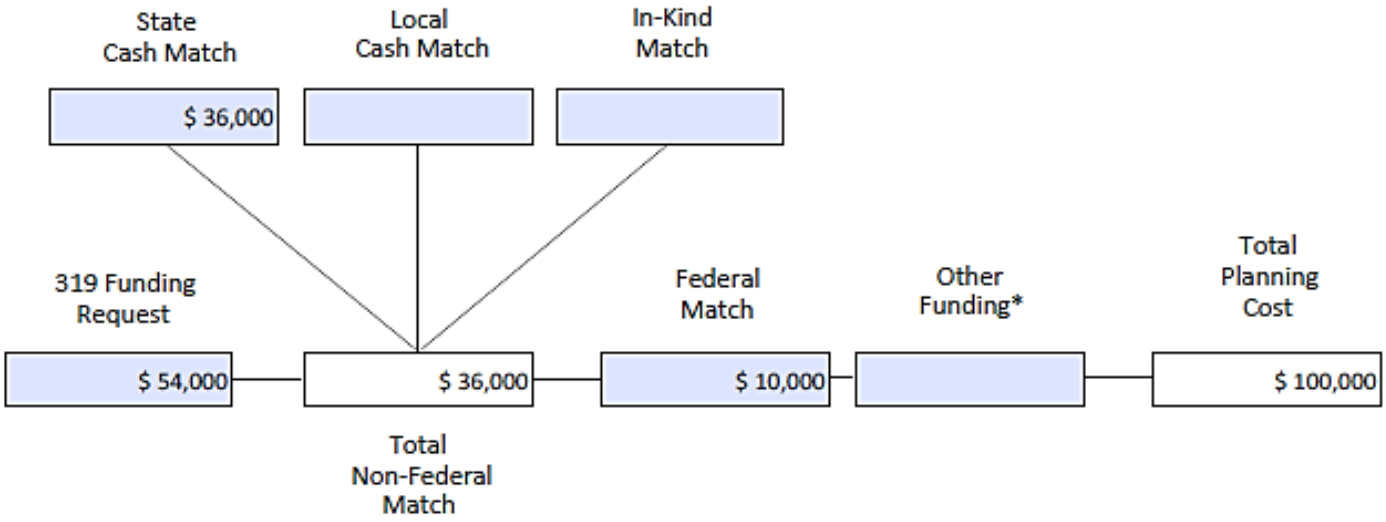
Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Implementation

Task 3 - Project Implementation Deliverables *(Include such things as construction oversight, implementation of on-the-ground restoration practices, preparation and submittal of as-built drawings, etc.)*

Contractor will submit to DEQ the following deliverables:
• Draft request for proposals (RFP) for DEQ review and comment (for implementation). Contractor shall submit draft RFP prior to release and allow at least 30 days for DEQ review, comment, and subsequent modification prior to release
• A final copy of the RFP
• Implementation of on-the-ground restoration including channel relocation, bank and roadside stabilization, possibly moving road, wood installation, and possible floodplain reconnection.
• A detailed description of any deviations from the final project map completed under project implementation task and an explanation for the need for each deviation.
• Lolo NF sign off on completed work



Match Source	Lolo National Forest	Secured	
Match Source	DNRC	Secured	
Match Source	FWP Future Fisheries Program	Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Other Activities

Use this task if the activities you are proposing are outside the scope of the typical design/implement/monitor process. Provide sufficient details to enable application reviewers to successfully compare the nonpoint source pollution reduction benefits of your project to those of other projects in the applicant pool.

Task 4 - Project Deliverables *(Include activities you will complete and the products you will submit to demonstrate completion.)*

State Cash Match	Local Cash Match	In-Kind Match	319 Funding Request		Federal Match	Other Funding*	Total Planning Cost
				$ 0			$ 0
				Total Non-Federal Match			

Match Source		Secured	
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Effectiveness Monitoring

The short duration (1-3 years) and limited spatial extent (often just a few hundred yards) of most 319-funded projects frequently precludes the use of traditional water chemistry monitoring as a means of evaluating project effectiveness. Instead, DEQ encourages project sponsors to use simpler, more qualitative tools. Typically, this will include pre- and post-construction photo point monitoring, vegetation mortality measurements, and perhaps modeling to estimate pollution load reductions. Please contact one of the DEQ Nonpoint Source Program staff for guidance relative to your specific project.

Task 5 - Project Effectiveness Monitoring Deliverables *(Identify the specific tools and products you will use to evaluate and demonstrate the effectiveness of your project in reducing nonpoint source pollution.)*

Contractor shall submit to DEQ the following deliverables:
• A complete draft monitoring plan for review and comment in electronic (Microsoft Word) format, allowing sufficient time for review, comment, and subsequent modification prior to implementation. The monitoring plan must identify the specific monitoring that will occur, who will complete the monitoring, and how the data will be analyzed and reported.
• A final monitoring plan. Contractor shall ensure that the final monitoring plan addresses all comments and concerns raised by DEQ.
• A written summary of all monitoring activities. The written summary must include the following:
o Electronic copies of photo-point photographs, in JPEG format. A photo log identifying photo ID, site ID, photo date, photographer name, latitude and longitude from which the photo was taken, approximate direction the photographer was facing, and a brief description of what the photo is intended to show.
o Electronic copies of all data and data analyses.
o A detailed description of any deviations from the final monitoring plan, and an explanation of the need for each deviation.
o An estimate of sediment load reductions, in tons/year, achieved through implementing on-the-ground projects.

State Cash Match	Local Cash Match	In-Kind Match			
		$ 2,000			
319 Funding Request			**Federal Match**	**Other Funding***	**Total Planning Cost**
$ 4,000	$ 2,000				$ 6,000
	Total Non-Federal Match				

Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Additional Attachments

Attach additional items that could help reviewers better understand your project. Items could include site photos, design drawings, site evaluations, permits, etc. Please be conscious of reviewers' time, as they may not have time to read lengthy studies and reports. List all additional attachments below.

- [x] Upper O'Brien Creek Stream Restoration Photos
- [x] O'Brien Creek Project Development report to DEQ (2021)
- [x] Bitterroot Watershed Restoration Plan (2020)
- [ ]
- [ ]
- [ ]

Additional information that could assist reviewers in evaluating the project's potential impact on NPS pollution.

Letters Of Support

USDA United States Department of Agriculture | Forest Service | Lolo National Forest | Building 24, Fort Missoula
Missoula, MT 59804-7297
406 329-3750

File Code: 2500
Date: October 25, 2021

Kristy Fortman
DEQ 319 Watershed Management Section Supervisor
Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

Dear Ms. Fortman,

The Lolo National Forest supports the Clark Fork Coalition's grant application for the Upper O'Brien Creek Stream Restoration Project. The Clark Fork Coalition is applying for grant funds from the Clean Water Act Section 319 Nonpoint Source (NPS) Program to work with the US Forest Service to reduce human-caused sediment sources and improve fisheries habitat in upper O'Brien Creek, an important cold water native fishery. The Lolo National Forest conducted a road survey and stream assessment in the watershed in 2019 and identified several active sources of sediment on the Forest – including significant active erosion from streambanks and road fill failures. Restoration work is necessary along O'Brien Creek to reduce sediment loading, restore stream and floodplain function, and improve in-stream wildlife habitat.

The Clark Fork Coalition and the Lolo National Forest have been working on cooperative projects for several years, including decommissioning 30 miles of roads in the upper Lolo Creek watershed, establishing temperature monitoring stations, collecting stream discharge data for instream flow management, working to understand beaver habitat feasibility and reintroduction, and a completed climate change watershed vulnerability assessment. The Lolo National Forest continues to provide funding to these efforts when possible. As such, the Clark Fork Coalition and the Lolo National Forest have a track record of proven success and are now continuing the partnership with the Upper O'Brien Creek stream restoration project.

Funds from the NPS Program are essential to completing on-the-ground reclamation projects and will be matched by state, federal, and private funds.

Thank you for the funding opportunity and your continued work for conserving natural resources. Please do not hesitate to contact me if you have any questions.

Sincerely,

JENNIFER HENSIEK
Missoula District Ranger

cc: Dustin Walters, Shane Hendrickson

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 local waterways. 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.

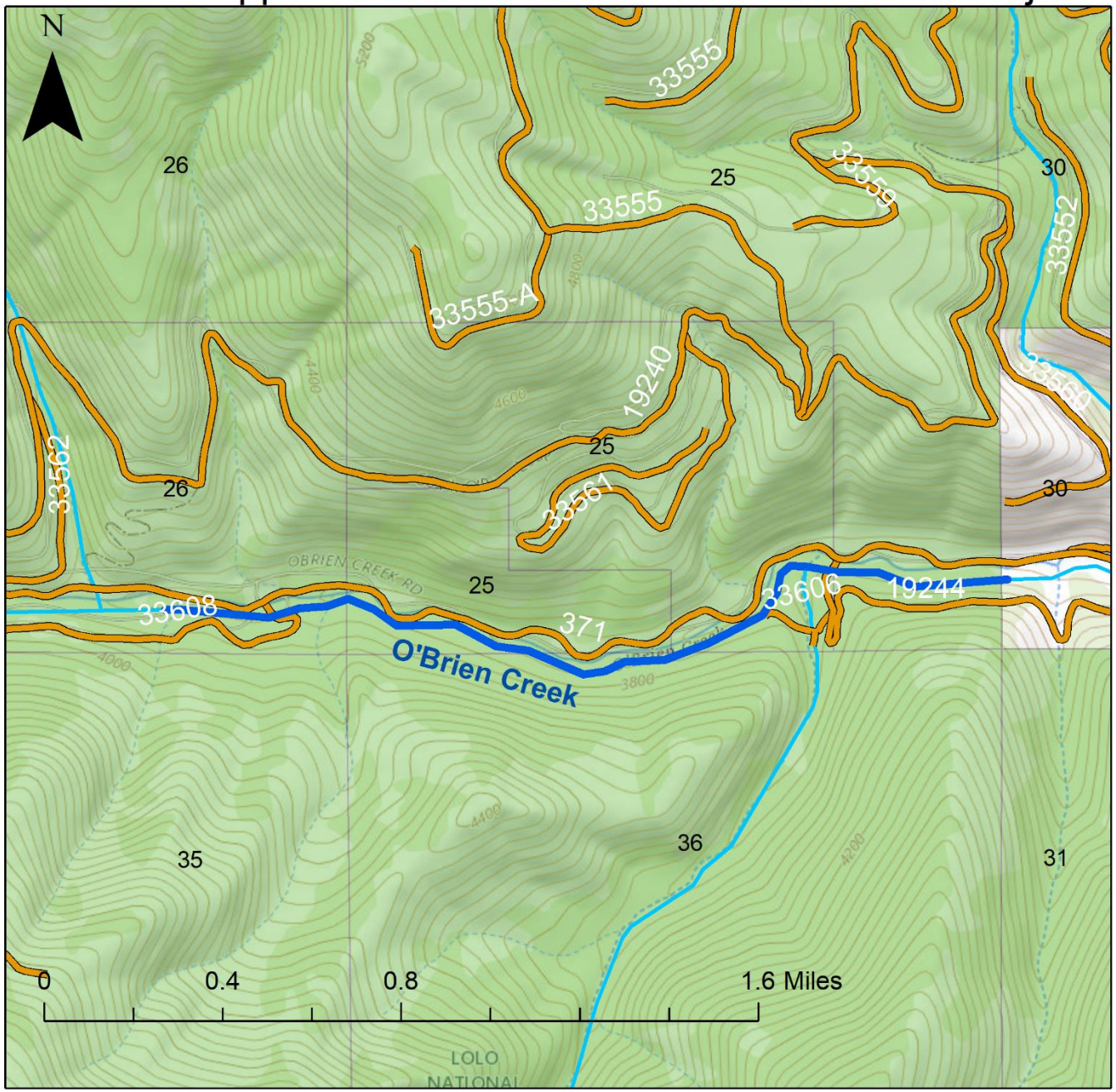
Thank you for the opportunity to demonstrate our support for this project.

Sincerely,

Elena Evans
Hydrogeologist
Missoula Valley Water Quality District

Project Map

Upper O'Brien Creek Stream Restoration Project



Legend

- Proposed Project Reach
- Roads
- Streams
- O'Brien Creek Watershed

Land Ownership

- USFS
- Private

CLARK FORK COALITION

Supplemental Information

Upper O’Brien Creek Restoration Needs Photos

A major road washout next to a Forest Service gate. This is the beginning of the reach to be restored.

The road failure is 6 feet in height and 54 feet long.

Road-associated erosion further upstream.

An example of an eroding bank.

Additional example of an eroding bank.

Additional example of an eroding bank.

An example of an incised streambank

An example of an incised streambank

Final Report for O'Brien Creek Project Development

Contract No. 221012

Adam Switalski, Project Manager, Clark Fork Coalition

September 2021

The Montana Department of Environmental Quality (DEQ) agreed to provide up to $5,000 to the Clark Fork Coalition (CFC) to develop plans and design projects that reduce sediment and improve hydrologic function in the O'Brien Creek watershed. The key components of the project include outreach to land owners and project partners, development of a conceptual restoration design, and fundraising efforts. Below is a summary of the tasks we have accomplished towards developing projects in the O'Brien Creek watershed.

1) Outreach strategies and activities, including lessons learned and about why landowners and potential project partners will or will not support watershed improvement.

We had several outreach activities including with public land managers and private landowners. The Forest Service is the largest landowner in the watershed and were instrumental in collecting data and helping prioritize restoration projects. The Lolo National Forest recently completed a stream assessment (2019) and summarized the results in the Bitterroot WRP (more information presented below).

In lower O'Brien Creek watershed there are 3 home owners associations (HOAs) that represent private landowners. O'Brien Creek Meadows is the lowest HOA and is part of an on-going restoration project. We have been working with John Muhlfeld (River Design Group; RGD) to assess and develop conceptual designs for the two upper reaches: Hillsdale Estates and O'Brien Valley Estates. We have contacted Aaron Pagiano, the son in law of Carolyn Diddel, the owner of Hillsdale Estates. On the Hillsdale Estates property is the landslide that has contributed to most of the degradation on the reach downstream on the O'Brien Creek Estates. It is essential that we also treat sections of this reach when working on the lower reach. We also spoke with Harvey Delger, HOA President from O'Brien Valley Estates. The O'Brien Valley Estates have several sections of the stream where the O'Brien Creek road is chronically delivering sediment. The land owners expressed concern about wildfires, and wanted any restoration project to include wildfire mitigation.

Once we assembled all the information on O'Brien Creek, we met with agency Fish Biologists and Hydrologists to help us prioritize which sites are most important to reduce chronic and episodic sedimentation and improve fish habitat. We met with two fish biologists, Ladd Knotek (MT FWP) and Shane Hendrickson (Forest Service) and Forest Service Hydrologists, Dustin Walters and Deanna DeWire, to gain their opinions.

The Forrest Service and MT FWP both agreed that O'Brien Creek is an important cold water fishery, especially for west-slope cutthroat trout, and that there are issues related to sedimentation. The lower section of O'Brien Creek is important migratory fish habitat, and the middle and upper section are important spawning habitat. They all agreed that addressing road-associated sediment delivery is important to mitigate, especially the road failure near the Forest Service boundary. While undersized

culverts in the headwaters are delivering sediment to the stream, they felt that addressing bank erosion and road-fillslope erosion on main-stem O'Brien Creek are the restoration priorities. We will continue to have conversations with private landowners and public land managers as we move forward with restoration efforts.

For lessons learned, the Forest Service continues to have limited resources available, but they are very supportive of our efforts to develop projects on the O'Brien Creek watershed. They are willing to provide staff time and resources, but have limited access to cash for these projects. For private land owners, we had some difficulty reaching with some land owners and HOA leadership. For example, we had difficulty connecting with Carolyn Diddel, but through talking with her neighbors, we were able to determine she was not living there at the moment and that her son-in-law was able to help us in project development.

2) Conceptual restoration design

For conceptual restoration design and project development in O'Brien Creek, we first compiled existing data and assessed priority lower reaches. We compiled stream survey and road survey data from the Forest Service, and hired River Design Group (RDG) to assess 2 lower reaches on private lands. The Clark Fork Coalition project managers have visited most of the identified restoration sites. Additionally, CFC re-took monitoring photos of roads decommissioned more than a decade ago along a tributay of O'Brien Creek.

Lower O'Brien Assessment and Conceptual Design for Reaches 1 and 2

River Design Group developed a conceptual restoration plan for. Three reaches from the blue mountain road to the top of the O'Brien Valley HOA. The designs included field photos of the existing condition, a map of existing stream channel and riparian conditions with the location of potential and preferred site-specific restoration treatments, and a description of potential and preferred site specific restoration treatments to address degraded site conditions. The designs also included LIDAR elevations for the three reaches.

RDG's findings and conceptual design are presented in Attachment 1 – O'Brien Creek Conceptual Restoration Plan. While DEQ has already provided funding for a conceptual design of the O'Brien Creek Meadows (in response to the emergency 310 permit), RDG also assessed and developed conceptual designs for two reaches upstream of O'Brien Creek Meadows. Below are a summary of the existing conditions, limiting factors and constraints, and restoration strategies.

Reach 1: O'Brien Valley Estates HOA

Existing Conditions:

Reach 1 encompasses 1,700 ft. of O'Brien Creek, and is the most functional stream reach of the assessment areas. The stream channel averages 12-15 ft. in width and exhibits low to moderate floodplain connection (B3 and G3 stream types). Aquatic habitat is dominated by riffles, the role of large wood is prevalent in the reach, forming step pool and lateral pool features. O'Brien Creek road encroaches on the channel and floodplain, and is a source of sediment and impairment to the creek. Relict channel scrolls in the floodplain attest to a historically more sinuous channel pattern.

Limiting Factors and Constraints:

O'Brien Creek road encroaches on the channel and serves as a chronic source of sediment. Channel entrenchment limits floodplain connectivity in most of the reach. Aquatic habitat is characterized by riffle habitat features with limited pools.

Restoration Strategies:

- Reduce road-stream channel interactions through channel re-location (Approximately 200 ft.)
- Evaluate opportunities to reconnect former floodplain surfaces by slightly raising the channel profile
- Increase the frequency and quality of pools throughout the reach with wood-based structures

Example of chronic bank erosion on O'Brien Creek

Reach 2: Hillsdale Estates Property Owners Association

Existing Conditions:

In reach 2 (1,600 ft.) O'Brien Creek becomes disconnected from its floodplain. Stream gradient increases, and the creek is dominated by riffle habitat features with limited pools (F3 stream type). Sediment loading increases due to eroding outside meander bends, high bank height ratios, and rotational slope failures on the south side of the valley. The channel is entrained along O'Brien Creek road for approximately 600 ft., resulting in simplified habitat conditions and sediment loading. Relict channel scrolls in the floodplain attest to a more sinuous, historical channel pattern.

Limiting factors and constraints:

O'Brien Creek Road encroaches on the channel and serves as a chronic sources of sediment. Channel entrenchment limits floodplain connectivity in most of the reach. Aquatic habitat is characterized by riffle habitat with limited pools. Hillslope (rotational) failures and eroding outside meander bends are significant sources of sediment.

Restoration Strategies:

- Reduced road-stream channel interactions through channel relocation (approximately 700 ft.)
- Evaluate opportunities to reconnect former floodplain surfaces by slightly raising the channel profile.
- Increase the frequency and quality of pools throughout the reach with wood-based structures
- Treat outside meander bends and hillslope failures to reduce sediment inputs to the channel.

Example of O'Brien Creek road delivering sediment into O'Brien Creek

Middle and Upper O'Brien Creek - Lolo National Forest Stream and Road Surveys 2019

In 2019 the Forest Service surveyed O'Brien Creek and the road system for sediment sources including road/stream crossings. This included mostly Forest Service lands, but also some private lands where access was allowed. The data was entered into ARC collector, and shape files and photos of sediment sources are included in our deliverables. CFC mapped and summarized the Forest Service findings in Attachment 2 – Lolo National Forest Stream and Road Surveys 2019 – Highlights.

PIBO

Two PacFish/InFish Biological Opinion (PIBO) monitoring sites on Obrien Creek. The primary objective of PIBO is to determine whether a suite of biological and physical attributes, and functions of upland, riparian, and aquatic systems are being degraded, maintained, or restored across the PIBO MP landscape. One PIBO site at the bottom of FS ownership (195 m long), and one PIBO site at the end of the FS road 123 (175 m long). At each PIBO site, the Forest Service measured Large Woody Debris (LWD), Habitat (pool tail depth, average pool depth, average pool length, and average riffle length), entrenchment, and pool tail fines. A summary of the PIBO data is found in Attachment 3 - O'Brien Creek Data and Language for the Bitterroot WRP


A road washed out next to Forest Service road and fillslope failures are high priority restoration opportunities in the watershed.

The Forest Service found several examples of bank erosion and road fillslope failures into O'Brien Creek (see photos). The largest active sediment source was a road washout next to a Forest Service gate. The dimensions of the fill slope failure are 54' x 8' x 6'. This site would be a priority for treatment. Another priority would be to treat this site and other nearby road fillslope failures into the creek in a future project. Treatment would include moving the road if possible and stabilizing the streambanks. The Forest Service surveys also found several undersized and perched culverts that are sediment sources. Decommissioning or upsizing some of these culverts is needed in the future.

Decommissioned Roads:

Several miles of roads were decommission in the O'Brien Creek watershed in the late 1990s. CFC revisited one site with a restored stream crossing. As you can see in the photo below, the restoration work and high levels of revegetation are successfully reducing sediment loads into the stream.


Photos of a restored stream crossing in 2007 and 2021.

Forest Service GIS Data
The Following GIS layers were attained from the Forest Service to aid in our watershed assessment:

- LNF_StreamSurveys_FieldForms - Reach Location
- LNF_StreamSurveys_FieldForms – Photopoints
- LNF_StreamSurveys_FieldForms - W_D
- LNF_Watershed_RoadSurvey - Stream Xing

Photos
CFC also compiled and labeled photos taken by the Forest Service in the following folders:

- O'Brien Creek FS road survey
- O'Brien Creek private below FS boundary
- O'Brien Creek decomm photos (take by CFC)
- PIBO at FS boundary
- Post-fire debris torrent ds upper PIBO site

3) **Summary of fundraising efforts**. This description will be accompanied by one or more draft funding applications, at a minimum to include a draft 319 proposal

We drafted an American Rescue Plan Act (ARPA) proposal for restoring 3 reaches on lower O'Brien Creek (Attachment 4 – ARPA proposal from CFC). Although we did not receive funding, this template will help us apply for additional funds. We are waiting for a final design of reach 1 and 2 on lower O'Brien Creek before drafting a DEQ grant proposal. Additionally, we plan to fundraise to restore the road washout and bank erosion sediment sources on Forest Service lands. Future opportunities to decommission / upsize culverts in the headwaters will also be sought.

2020

Bitterroot Watershed Restoration Plan

Bitter Root Water Forum

1/6/2020

Acknowledgements

This Watershed Restoration Plan (WRP) was developed through collaboration amongst people invested in the conservation and restoration of the Bitterroot watershed. Special thanks to those who provided the Bitter Root Water Forum (BRWF) invaluable input towards producing this document, including the Bitterroot National Forest (BNF); Clark Fork Coalition (CFC); Montana Fish, Wildlife & Parks (FWP); Missoula Valley Water Quality District (MVWQD), Missoula County, Lolo Watershed Group, Lolo National Forest (LNF), and Trout Unlimited (TU). The members of the BRWF's Projects Committee also deserve recognition for their assistance in the construction and revision of the WRP. Finally, this WRP could not have been completed without support from the Montana Department of Environmental Quality (DEQ), especially critical support provided from Water Quality Specialist Hannah Riedl.

Contents

SECTION 1: INTRODUCTION

The Bitterroot watershed covers nearly 3,000 square miles in western Montana's Rocky Mountains. For the area's more than 40,000 residents, the economy and the quality of life in the Bitterroot Valley depend on ensuring a healthy watershed that will always provide clean, abundant water and healthy wildlife habitats.[1] This, in turn, requires monitoring, protecting, and improving water quality and quantity. The Bitter Root Water Forum (BRWF) was established in 1993 as an educational and discussion forum for all water users in the Bitterroot watershed, from farmers to anglers. We have since evolved into a collaborative watershed group dedicated to ensuring clean water for future generations.

We are working for the day when:

- Residents and visitors appreciate how integral the Bitterroot River is to the valley's social, ecological, and economic well-being and make caring for and protecting the river a top priority.
- Urban and rural neighbors work together, using science and local wisdom, to proactively and continually maintain and improve water quality in our watershed.
- The Bitterroot River system continues to provide for diverse uses while achieving its potential as a world-class fishery and top-quality aquatic habitat.

BRWF produced this Watershed Restoration Plan (WRP) to coordinate watershed restoration efforts amongst other partners (Section 1.2) and implement the steps necessary to sustain future restoration projects and long-term education. This WRP is based upon the principles established by our founders in 1993 and reflects our continued commitment to restore and protect the Bitterroot watershed through education and restoration projects. We honor our traditional goals of bringing people together to understand our watershed while striving to preserve our aquatic habitats and resources.

1.1 WRP Design

Under the 1987 amendments to the Federal Clean Water Act, Section 319, the U.S. Environmental Protection Agency (EPA) provides funding to states to mitigate nonpoint source (NPS) pollution (i.e., pollution arising from diffuse sources such as land runoff, precipitation, atmospheric deposition, drainage, seepage, or manmade changes to natural water flow). Consistent with BRWF's founding dedication to a science-based approach, the data in the following documents provided much of the information used to guide the development of this WRP:

- Total Maximum Daily Load (TMDL) documents prepared by the Montana Department of Environmental Quality (DEQ);
- Bitterroot Subbasin Plan for Fish & Wildlife Conservation (Subbasin Plan);
- 2018 Integrated Report (IR) on Montana impaired waterbodies;
- Other planning and report documents for the Bitterroot watershed.

In 2012 and 2019, BRWF received Section 319 funds from DEQ to produce and update this WRP. EPA lists nine key elements critical for achieving water quality improvements and which must be included in all WRPs supported with Section 319 funding. The elements are listed below and are therefore included in this WRP.

[1] Clark Fork Coalition. *2017 Bitterroot Watershed Strategy.* Web.

NINE MINIMUM ELEMENTS OF AN EPA WATERSHED RESTORATION PLAN[2]	
1.	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. (Section 3)
2.	An estimate of the load reductions expected from management measures. (Section 3)
3.	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in number 2, and a description of the critical areas in which those measures will be needed to implement this plan. (Section 3)
4.	Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan. (Section 5)
5.	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented. (Section 6)
6.	Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious. (Section 4)
7.	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented. (Section 4)
8.	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards. (Section 7)
9.	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above. (Section 7)

Figure 1: US EPA's Nine Minimum Elements of a Watershed Restoration Plan

This WRP provides a broad overview of how BRWF and partners hope to address water quality concerns in the Bitterroot watershed.
For each priority subwatershed, the following information is provided:

1. Description of the subwatershed and its need for restoration and education;
2. Stream impairment information per DEQ TMDL reports (Element #1);
3. Necessary pollutant reduction loads per DEQ TMDL reports (Element #2);
4. Potential restoration activities and their associated benefits (Element #3);
5. Descriptions of completed, ongoing, and planned restoration projects.

These sections are followed by descriptions of:

1. Restoration milestones and schedule for the coming years (Element #6 and Element #7);
2. The technical and financial assistance needed to accomplish these goals (Element #4);
3. Education and outreach activities associated with these projects (Element #5);
4. Monitoring and evaluation criteria (Element #8 and Element #9).

The BRWF maintains a five-year work plan to guide project efforts which is reviewed and updated annually. The first edition of the WRP was produced in 2014 and we will continue to update it on a five-year cycle to include new information, completed restoration actions, and future plans. We hope this

[2] US Environmental Protection Agency. *Introduction to Watershed Planning.* Web.

structure and format will create a user-friendly guide to restoration efforts in the Bitterroot watershed for years to come.

1.2 Collaboration

While BRWF was a lead organization in drafting the WRP, some of the restoration actions and projects addressed in this plan will be completed by other partners and organizations working in the Bitterroot watershed. In an effort to embrace local knowledge and include priorities beyond those of BRWF, we invited interested parties to assist in developing the WRP. These stakeholders included:

- Bitterroot National Forest
- Clark Fork Coalition
- Montana Fish, Wildlife & Parks
- Trout Unlimited
- Missoula Valley Water Quality District
- Missoula County
- Ravalli County
- Bitterroot Conservation District
- Missoula Conservation District
- Lolo Watershed Group
- Lolo National Forest

Stakeholders offered information regarding current and aspirational projects, restoration opportunities, and plans within the watershed. This WRP is therefore reflective of the priorities of the BRWF as well as our partners working in the basin.

1.3 Selection of Priority Streams

The purpose of the WRP is to develop a strategic and achievable approach to restoration and education efforts. In order to do this, BRWF and stakeholders selected priority areas of focus within the Bitterroot watershed. While the process of choosing priority areas was influenced heavily by TMDL reports and recommendations from the Subbasin Plan, social aspects and historical context were also considered. Key questions included:

- Which streams have been most severely impacted by NPS pollutants?
- Is there currently momentum toward restoration in the subwatershed?
- Do any partners have connections and relationships with landowners in the area?
- What conservation efforts have landowners historically engaged in and how can we further educate about opportunities for restoration?

By collectively discussing organizational priorities and initiatives, we were able to uncover overlapping priorities and streams of interest; In turn, 13 priority streams in the Bitterroot watershed were identified which will be the focus of this plan and of restoration efforts for the next 5 years.[3]

[3] WRPs specific to Lolo Creek and Miller Creek have been produced by partner organizations. While these streams are of priority in the Bitterroot Watershed, they are not discussed at length in this WRP. Miller Creek is included as a priority stream in this WRP as well because it is a project focus for the co-authors of this WRP, including the Bitter Root Water Forum and Clark Fork Coalition.

1.4 Maps

The following maps represent the subbasins encapsulated by the priority streams listed in section 3 of this document. Further, these maps indicate the locations of impaired waters identified by DEQ in the Bitterroot and Bitterroot Headwaters TMDL planning areas.[4] [5] The four most common probable causes of impairments in the Bitterroot watershed are sedimentation/siltation, nutrients (including phosphorus, nitrogen, chlorophyll-a, nitrate, and nitrite), temperature, and flow regime modification. Accordingly, the geographic reaches that each of these causes affects is explored in the following maps.

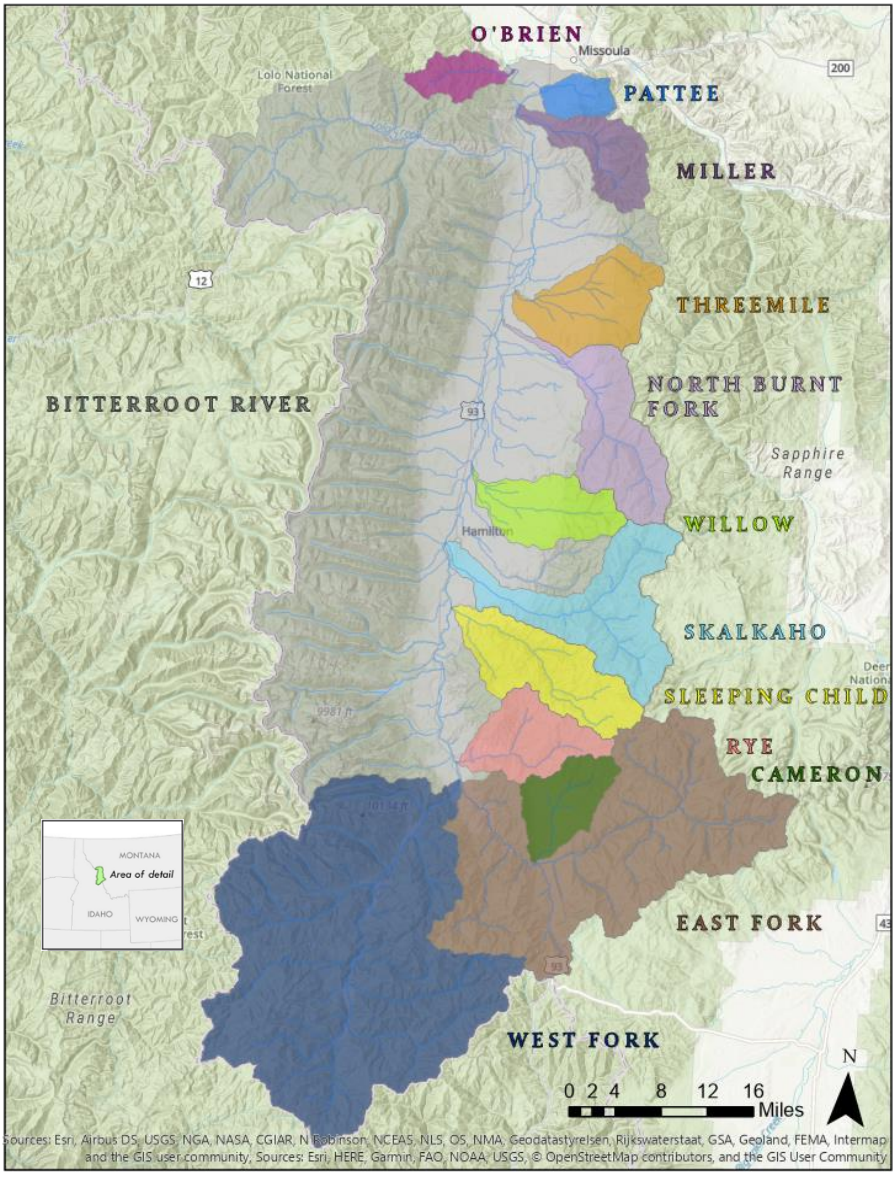


Figure 2: Priority subbasins in the Bitterroot watershed as described in this WRP.

[4] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters*. Helena: Montana. Department of Environmental Quality [2018]. Web.

[5] Streams in the Lolo watershed (Lolo Creek and Lolo Headwaters planning area) are not included. Please see the Lolo WRP for further information on these streams.

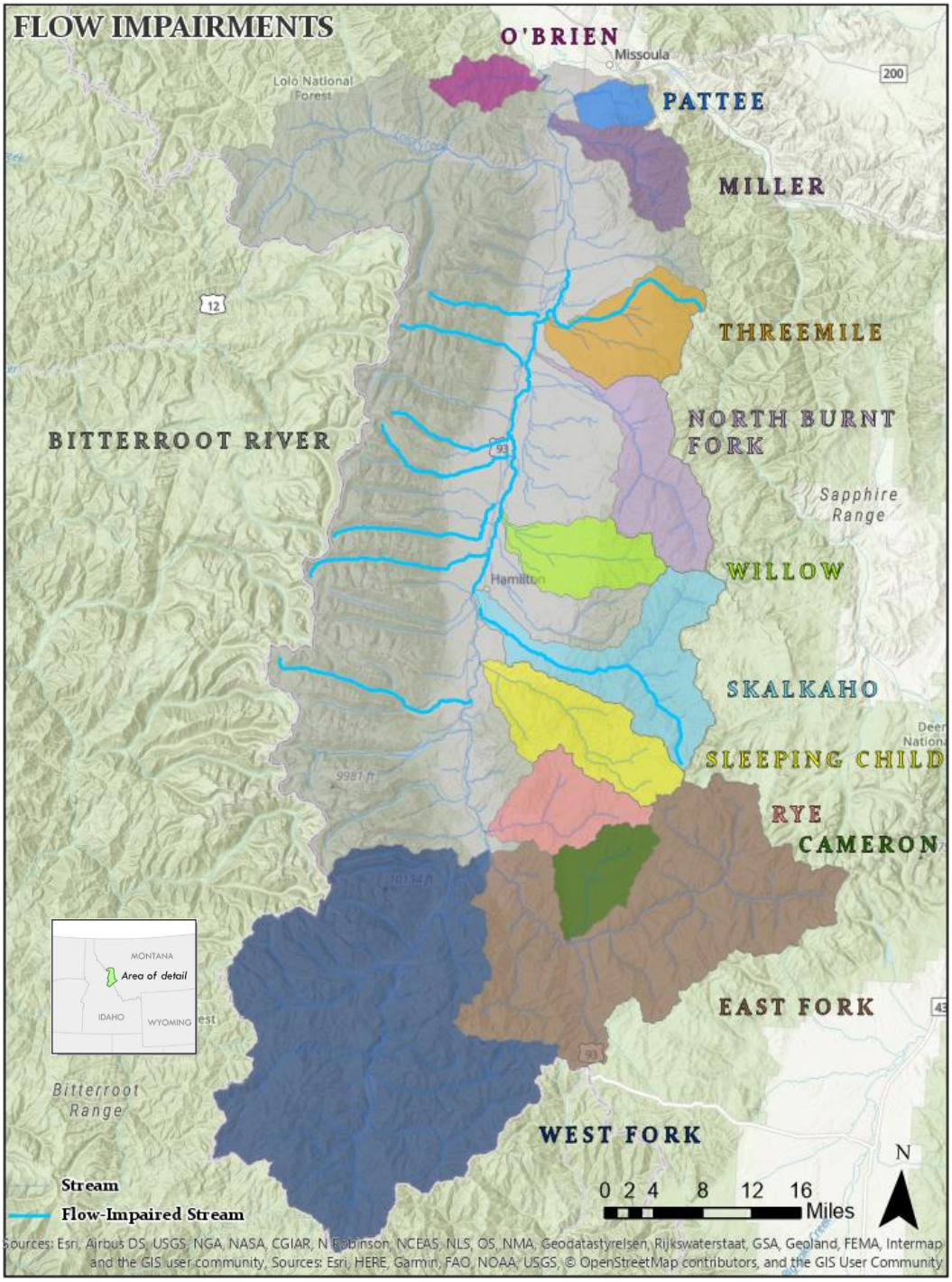


Figure 3: Streams impaired by flow regime modifications.

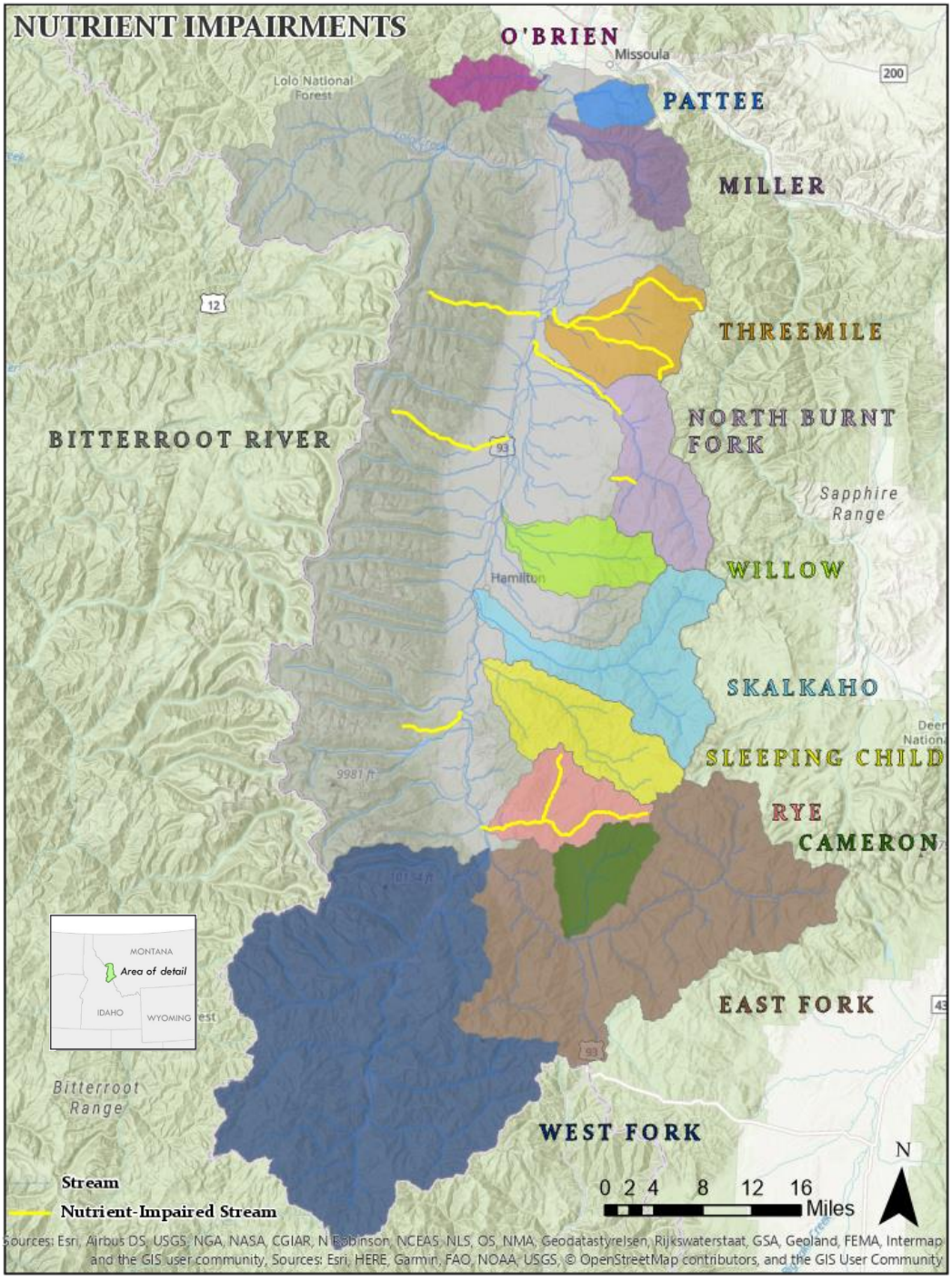


Figure 4: Streams impaired due to nutrient levels.

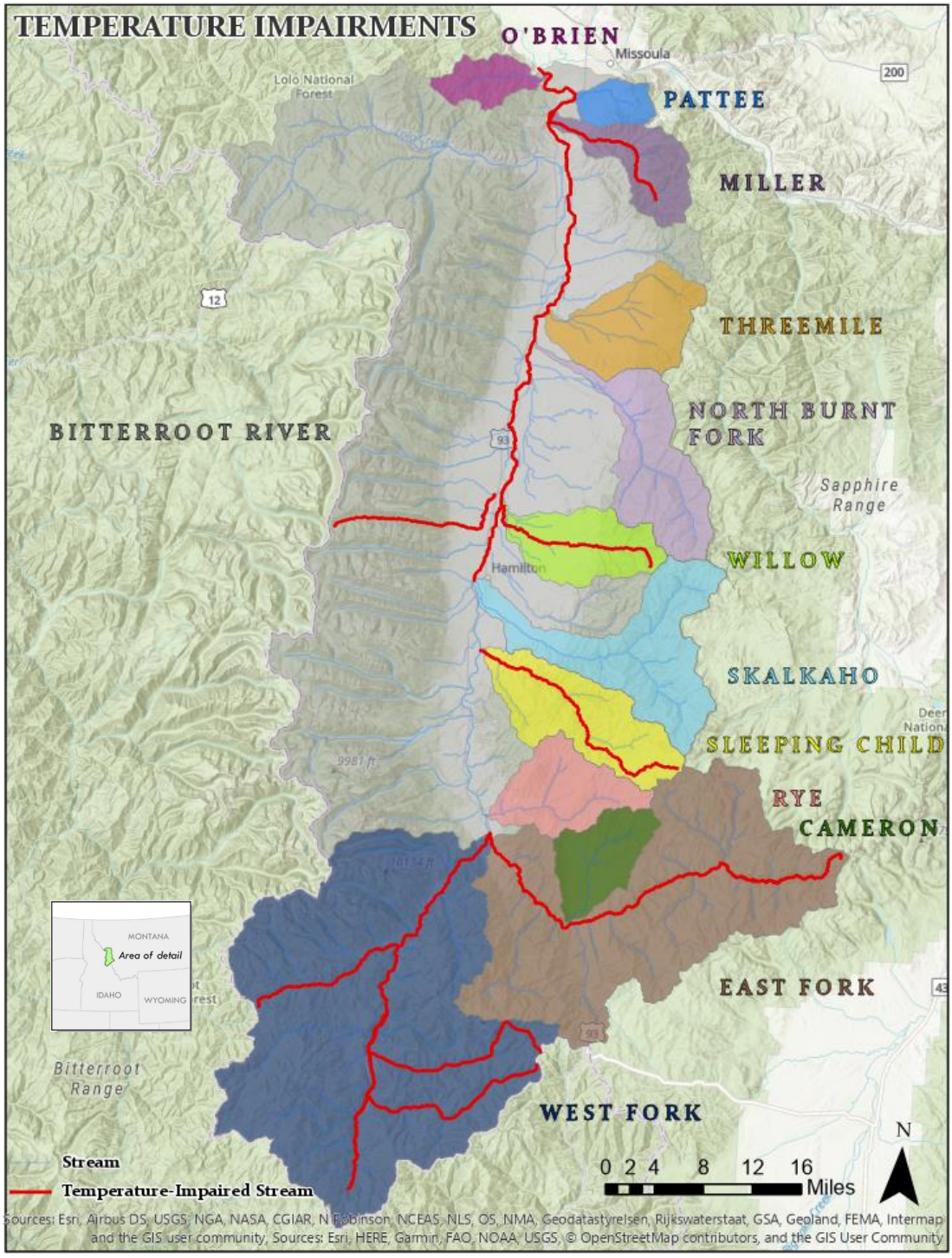


Figure 5: Streams impaired due to temperature.

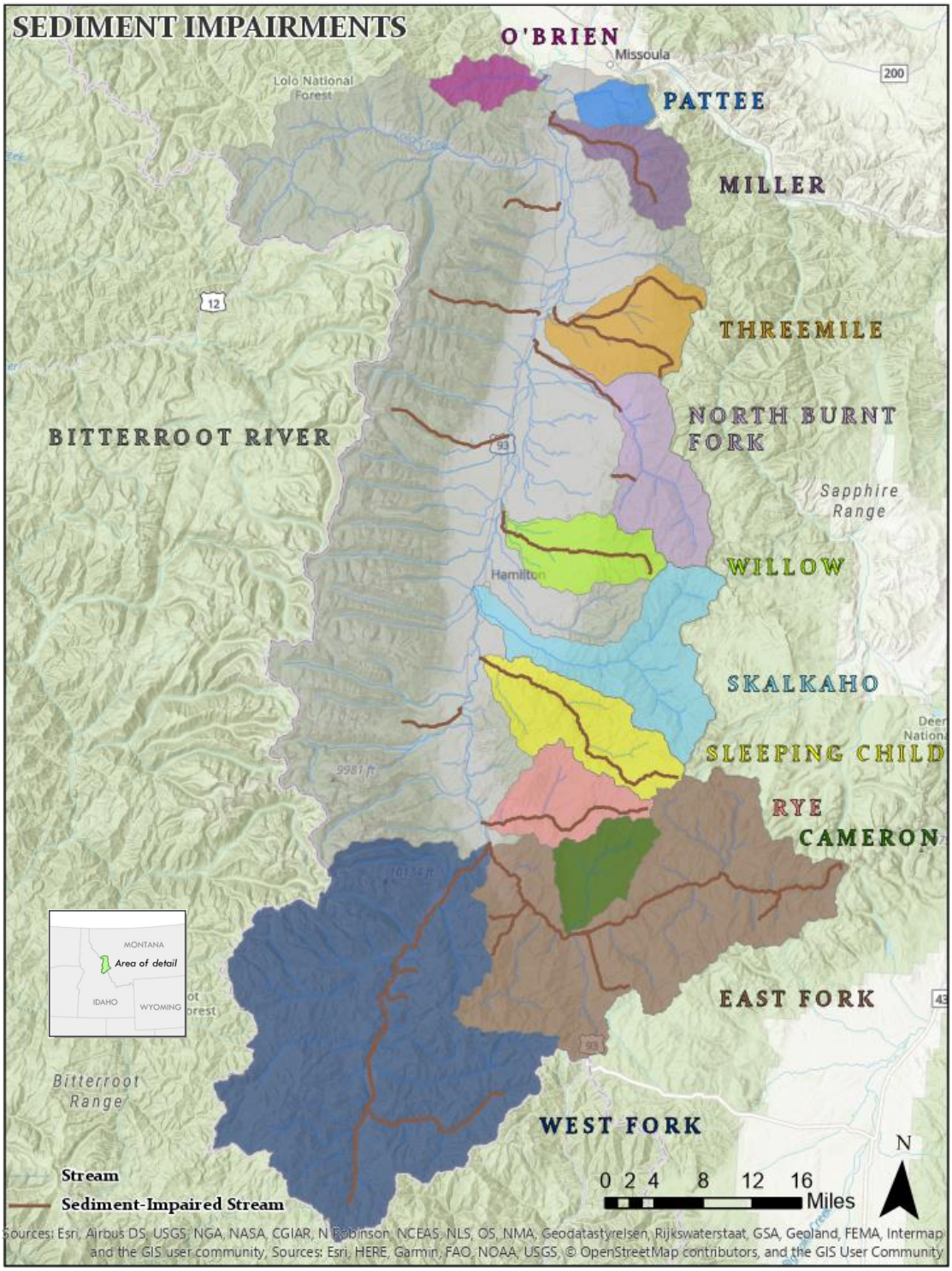


Figure 6: Streams impaired due to sediment levels.

SECTION 2: THE BITTERROOT WATERSHED

Located in the Rocky Mountains of western Montana, the Bitterroot watershed encompasses 2,899 square miles. It is bordered by the crest of the Bitterroot Mountains to the west, the crest of the Sapphire Mountains to the east, the headwaters of the Bitterroot River to the south at Lost Trail Pass on the Idaho–Montana border, and the confluence of the Bitterroot River with the Clark Fork River to the north in Missoula County. The watershed is contained within Ravalli County, with just a small portion of its northern boundary falling within southern Missoula County.

The Bitterroot watershed is characterized by a wide valley and meandering river channel with riparian forest and floodplain. The watershed includes high, glaciated mountains with alpine ridges at higher elevations and glacial and lake basins at lower elevations. Elevations range from 10,131 feet at Trapper Peak in the Bitterroot Mountain Range to 3,120 feet on the valley floor. [6]

The Bitterroot watershed is complex for a number of reasons:

1. **Tributaries –** While most recreational use occurs on the Bitterroot Mainstem, its many tributaries provide flow and spawning habitat. Because of these many tributaries, the Bitterroot watershed is a complex system with many opportunities for degradation and improvement.
2. **Climate –** The Bitterroot Valley is arid, receiving 12 inches of rainfall per year, though as much as 100 inches falls in the surrounding mountain ranges. Rivers in the watershed are snowmelt dominated systems that experience large changes in flow rates from season to season.[7]
3. **Irrigation –** Established in the late 1800s, the primary irrigation systems of the valley are comprised of several irrigation districts managing large canal systems. These are some of the oldest, largest and most complex irrigation systems in Montana. Due to the dry climate in the valley bottom, this system is crucial to sustaining the economy and lifestyles of Bitterroot Valley residents, as it disperses the high mountain rainfall throughout the valley and the dry summer. However, this system contributes to the dewatering and altered flows of streams in the watershed.[8]
4. **Land Ownership and Land Use –** The valley bottom of the Bitterroot is generally privately owned for residential or agricultural use. The irrigation system supported early subdivision of lands into small agricultural parcels, setting the stage for fragmentation of private lands. Conversely, most high-elevation, headwater areas are public land with relatively intact habitat; ownership includes the U.S. Forest Service and state of Montana.[9]
5. **Demographics –** High growth rates and corresponding demographic trends have shifted the economics of Ravalli County to less of an emphasis on traditional agriculture and timber industries.[10] In addition, a portion of the watershed lies within Missoula County as well as the city of Missoula. Between 2010 and 2018, Ravalli County's population increased by 7.4% and Missoula County's at 8.7%, making these two of the fastest-growing counties in Montana.[11]
6. **Recreation** – The Bitterroot valley is a highly popular fishing destination, regularly ranking in the Top 5 statewide. In the 2017-2018 license year, the Bitterroot Mainstem supported 102,388 angler days, 41% of which were non-resident;[12] this industry is an important piece of the Bitterroot Valley's economy.
7. **Fire -** In recent decades the watershed has experienced several extremely large and/or high intensity fires, including in 1996, 2000, 2013, and 2017. While fire is a natural force in the area, it can

---

[6] Clark Fork Coalition. *2017 Bitterroot Watershed Strategy.* Web.
[7] Montana Department of Natural Resources and Conservation. *Habitat Conservation Plan.* Web.
[8] Clark Fork Coalition. *2017 Bitterroot Watershed Strategy.* Web.
[9] Oberbillig, Deborah Richie. *Taking Care of the Bitterroot Watershed.* Bitter Root Resource Conservation and Development Area, Inc. 2005. Print. p .5
[10] Oberbillig, Deborah Richie. *Taking Care of the Bitterroot Watershed.* Bitter Root Resource Conservation and Development Area, Inc. 2005. Print. p .4
[11] United States Census Bureau. QuickFacts. Web.
[12] Montana Fish Wildlife and Parks (FWP). Angler Pressure Survey Summary [2018] Accessed online at: http://fwp.mt.gov/fwpDoc.html?id=91831

contribute large amounts of sediment to water bodies, and the response of the watershed to the fire depends on its health beforehand.[13]

Figure 7: View of high glaciated mountains with alpine ridges and lower elevation lake basin from above Tin Cup Lake/Reservoir. Tin Cup Lake is a natural lake that has become much larger in size because it has been dammed for water storage.[14]

13 Oberbillig, Deborah Richie. *Taking Care of the Bitterroot Watershed.* Bitter Root Resource Conservation and Development Area, Inc. 2005. Print. pp. 18-19.

14 Photo courtesy of M. Hoyt, 2011

SECTION 3: PRIORITY STREAMS - IMPAIRMENTS, MANAGEMENT MEASURES, LOAD REDUCTIONS, AND PROJECTS (EPA ELEMENTS #1, #2, and #3)

3.1 Section Guide

The following chapters are dedicated to each of the Priority Streams in the Bitterroot; the components below are provided in each Priority Stream chapter.

Description[15]

A brief background of the Priority Stream is provided, including information such as location, fluvial processes, and significance to human and wildlife populations.

Stream Impairments[16]

Every 2 years per federal requirements, DEQ compiles the Integrated Report (IR), which includes a list of waterbodies that are failing to meet water quality standards. Known as the 303(d) list, it identifies water bodies throughout Montana whose beneficial uses are impaired. 39 impaired streams in the Bitterroot watershed are included in the 2018 IR. Not all streams in the Bitterroot watershed have been studied by the DEQ and are thus not classified as impaired by definition. However, the restoration needs of these streams are still considered as they may be contributing pollutants to higher-order, officially impaired rivers downstream.[17] 13 streams (10 of which are included on the 303(d) list), were chosen as priority streams to be the focus of restoration efforts as detailed in this WRP.

The IR includes information on the causes of impairment for a stream, and on the probable sources of pollutants. A TMDL is the maximum amount of a pollutant allowed to enter a waterbody so that it can still meet its water quality standards. Each of the 13 priority streams in this WRP is a stream of concern for one or more of the following pollutants:

- Sedimentation/siltation
- Temperature
- Alteration in stream-side or littoral vegetative covers
- Flow regime modification
- Phosphorus, total
- Nitrogen, total
- Nitrate/Nitrite (Nitrite + Nitrate as N)
- Physical substrate habitat alterations
- Lead
- Aluminum
- Fish passage barrier
- Chlorophyll-a

The two most common problems among priority streams in the Bitterroot watershed are increased sediment and temperature, followed by alterations in streamside or littoral vegetative cover. The "Stream Impairments" sections of the WRP lists specific problems and contributing factors for each priority subwatershed. Also included is a chart highlighting the pollutant category, affected beneficial uses, and status of the TMDL.

---

15 Stream description information is derived from: Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan.* Helena:Montana. Department of Environmental Quality [2011]. Web.

16 All stream impairment tables are derived from: Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters*. Helena: Montana. Department of Environmental Quality [2018]. Web.

17 Jakober, Michael J. *CameronBlue Ecoburn: Biological Assessment and Evaluation*. [Sula, MT] U.S. Forest Service, Bitterroot National Forest [2011].

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Complete	Source of Impairment Cause
The problem with the stream that interferes with its beneficial uses; may be a pollutant, such as "lead" or another type of issue, such as "alterations in stream-side or littoral vegetative cover"	*The category in which the pollutant is grouped for purposes of TMDLs e.g. Nutrients, Metals, Temperature*	*Desirable uses that water quality should support: aquatic life, agriculture, drinking water, and primary contact recreation*	*Whether a TMDL Report has been completed for this pollutant*	*List of activities that may have caused or worsened problems in this stream; sources of pollutants*

Figure 8: Definitions of terms summarized from the 2018 IR and provided for each priority stream.

Pollutant Load Reduction Goals

One of BRWF's main goals is to improve water quality such that all waterbodies in the Bitterroot watershed are supporting all of their beneficial uses. We expect the management measures called for in this WRP will help achieve some of the load reductions identified in the TMDLs. The load reduction needs for each subwatershed are derived from the Bitterroot River Headwaters TMDLs and the Bitterroot River Mainstem TMDLs. Each subwatershed chapter has a table describing the necessary load reductions in sediment, temperature, metals, and/or nutrients to meet TMDLs. Meeting these necessary load reductions is the prime directive of the restoration actions developed by BRWF.

Management Measures

This section includes a description of the NPS management measures needed to begin achieving the load reductions described in Section 6 and a description of the critical areas where this WRP proposes implementing those measures. The recommendations described here were derived in part from the Subbasin Plan, which was developed by a number of regional organizations in 2009 to collectively assess subwatersheds and provide recommendations for conservation actions. The Subbasin Plan includes a comprehensive list of management needs, and we used the plan as a guide for selecting and prioritizing projects for this WRP's 5-year work plan.

For each priority stream, a table of restoration activities that would likely benefit this particular stream is provided. These activities are selected to address the pollutants and other impairment causes in the stream, with the aim of restoring the stream's beneficial uses. The table includes management measures that have been implemented since 2014 as well as measures that can be implemented in the near future. Specific projects and management needs may change over time as new opportunities or threats arise. If priorities change, necessary NPS management measures will be adjusted accordingly.

Projects

Since the publication of the first WRP in 2014, a number of restoration projects have been undertaken by the BRWF and our partners on the Bitterroot's Priority Streams. For each stream, available information on past, ongoing, and planned projects is provided.

BRWF focuses largely on riparian revegetation projects. These usually result in benefits to sediment, temperature, and nutrient loads as well. Because of this relationship, the interconnected nature of NPS pollutants is taken into account when BRWF develops restoration projects. For some streams, special considerations were made to address aquatic species of concern, and specific recommendations to improve fisheries are included.

3.2 Mainstem Bitterroot River

Description

The mainstem Bitterroot River stretches over 80 miles, from the confluence of the East and West Forks near Darby, northward to Missoula where it enters the Clark Fork River. It is the largest tributary to the Middle Clark Fork River. While restoration actions generally focus on tributaries rather than the mainstem, the River carries the cumulative impacts of all Bitterroot watershed streams, both in terms of impairments and improvements. The mainstem Bitterroot was specifically included because of growing concerns about nutrient exceedances in the lower reach. The DEQ's TMDL documents divide the Bitterroot River into the following reaches:

1. **Upper Mainstem Bitterroot River:** Stretching from the confluence of the East West Forks near Darby to the mouth Skalkaho Creek, just south of Hamilton, the upper portion of the Bitterroot River flows roughly 25 miles through the southern part of the Bitterroot Valley in Ravalli County. The relative narrowness of valley in this reach leaves less room for agriculture and development. This upper portion of the river is home to an important stronghold of native Westslope Cutthroat trout as well as Bull trout, which use the Bitterroot mainstem as valuable summer and over-wintering habitat and access the tributaries and forks when spawning.
2. **Middle Mainstem Bitterroot River:** The middle reach of the Bitterroot River flows approximately 27 miles across the broad valley floor from Skalkaho Creek near Hamilton to Eightmile Creek near Florence. As the valley widens, the river becomes more dynamic with relic channels, oxbows and regular lateral migration during flood events. The shifting nature of the river is often in conflict with agricultural and residential use in the valley. This has led to efforts to stabilize banks (often with rip rap) and straighten the river, greatly altering its natural profile and function. The Middle Mainstem is also the most severely dewatered section of the Bitterroot, specifically the 17 miles between Corvallis and Stevensville (before groundwater and irrigation returns begin to increase flows in the River).[18] Although target flows for Painted Rocks Reservoir releases are set for 400 CFS at Bell Crossing, this location regularly drops to 200 CFS during dry years. The middle section of the Bitterroot River is still home to native populations of Cutthroat and small numbers of Bull Trout, while continuing to provide valuable over-wintering habitat. However, non-native trout become most prevalent in this stretch and further downstream.
3. **Lower Mainstem Bitterroot River:** Continuing northward, the lower reach of the Bitterroot River flows from Florence to its mouth at the Clark Fork River in Missoula County, just west of Missoula. Carrying water that originated above 10,000 feet elevation in the Bitterroot Mountains, the mouth of the Bitterroot River enters the Clark Fork River at approximately 3,100 feet elevation, with an average peak runoff of roughly 8,000 CFS and a base flow of roughly 1,000 CFS. The broad lower section of the river continues to meander through agricultural lands and faces many of the same alterations to flow, temperature, and riparian vegetation faced farther upstream. The lower river is dominated by non-native trout species. The lower river additionally faces development-related impacts as it flows through the Missoula metropolitan area. For example, winter road maintenance and stormwater runoff contribute sand and chloride ions into the river. Further, heavy streamside development is of particular concern to channel migration, which is part of the river's natural function.

[18] Montana Fish Wildlife and Parks. *FWP Dewatering Concern Areas, Revised.* Montana FWP [2005]. Web.

Stream Impairments[19]

Stream Section	Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Complete	Source of Impairment Cause
Upper Bitterroot River (confluence of East and West Forks to Skalkaho Creek)	Alteration in stream-side or littoral vegetative covers	N/A; non-pollutant	Aquatic Life	N/A	Grazing in Riparian or Shoreline Zones Rangeland grazing Streambank modification/destabilization
Middle Bitterroot River (Skalkaho Creek to Eightmile Creek)	Flow Regime Modification	N/A; non-pollutant	Aquatic Life	N/A	Agriculture Crop production (irrigated)
	Temperature	Temperature	Aquatic Life	Yes	Agriculture Wet weather discharges (NPS)
Lower Bitterroot River (Eightmile Creek to mouth at Clark Fork River)[20]	Alteration in stream-side or littoral vegetative covers	N/A; non-pollutant	Aquatic Life	N/A	Rangeland grazing Wet weather discharges (point source, stormwater, SSO, CSO)
	Lead	Metals	Aquatic Life	Yes	Source unknown
	Temperature	Temperature	Aquatic Life	Yes	Agriculture Wet weather discharges (NPS)

[19] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters.* Helena: Montana. Department of Environmental Quality [2018]. Web.

[20] In 2013, the Lower Bitterroot River was delisted for Nitrogen (Nitrate) based on "Applicable WQS [water quality standards] attained; According to new assessment method" (DEQ 2013). However, nutrient levels remain high in this reach and remain a concern for agencies and partners working in the valley.

TMDLs and Load Reductions

Temperature[21]

The temperature TMDL is based off compliance with Montana's water quality standards. For B-1 waters, the beneficial use type that the Bitterroot is classified as, that standard is defined as "the maximum allowable increase over the naturally occurring temperature is 1*F if the naturally occurring temperature is less than 66*F. Within the naturally occurring temperature range of 66 to 66.5 °F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5° F".

To achieve the temperature target in the Middle and Lower segments of the Bitterroot River, the TMDL recommends several linkages to temperature be addressed: riparian and stream channel conditions, headwater and tributary thermal influence, wastewater influences, and irrigation withdrawals and return flows. The linkages that this Watershed Restoration Plan will focus on are covered in more detail below.

- Riparian and stream channel conditions: The TMDL recommends increasing effective shade in the middle and lower Bitterroot River by 0.5%. It also recommends no increase in channel width.
- Tributary temperature: The TMDL recommends a focus on reducing instream temperatures in East Fork and West Fork Bitterroot Rivers, Hayes, Threemile, Kootenai, McClain, and Tin Cup Creeks. See Sections 3.3, 3.4, and 3.11 in this WRP for management measures this WRP recommends implementing in the East Fork, West Fork, and Threemile Creek.
- Irrigation water: The TMDL recommends a 15% increase in irrigation withdraw efficiency during mid-June through August, and a reduction in volume of warm water returned by 75%.

Lower Bitterroot River Lead Example TMDLs[22]

All lead exceedances in the Bitterroot River occurred during spring runoff conditions. This indicates that lead is likely bound to sediment and enters waterways from overland flow and erosion or resuspension of contaminated sediment already in the stream bed. However, no single, obvious cause to the lead impairment is evident based on the available data.

	High Flow	**Low Flow**
Discharge (CFS)	9260	750
Hardness (mg/L)	25	77
Measured Pb Concentration (µg/L)	2.37	2
Target Pb Concentration (µg/L)	0.54	2.28
TMDL (lbs./day)	27.00	9.23
% required load reduction to meet TMDL[23]	77%	0%

21 Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 6-5 and 6-11. 2011.

22 Montana Department of Environmental Quality. *Final - Bitterroot Watershed Total Maximum Daily Loads and Water Quality Improvement Plan*. Helena: Montana. Department of Environmental Quality [2014]. Document No. C05-TMDL-03aF. Table 6-8. Print.

23 Based on the highest single sample concentration

Management Measures

Management measures for temperature will focus on restoring shade and instream flow in temperature-limited tributaries to the Bitterroot River, and within the Bitterroot River corridor itself. This includes targeted riparian fencing and planting, irrigation efficiency projects and potentially instream flow transactions. BRWF and partners do not have immediate plans to address lead exceedances in the Bitterroot River. However, we recognize that with increased development in the Bitterroot Valley and increased monitoring, projects related to either metals or nutrients may become a priority. We will continue to work with the DEQ and other water quality monitoring programs to assess and address impairments in the river as they arise.

Projects

Restoration activities on the Bitterroot River will focus on riparian revegetation and public outreach and educational opportunities. We will continue primarily focusing on efforts to improve water quality in tributaries flowing into the River.

- In 2019, BRWF and FWP began a streambank revegetation project at the heavily-trafficked Stevensville Fishing Access Site in the Middle Bitterroot River. This project is anticipated to reduce water temperature and benefit aquatic life due to increased riparian shading. DEQ has provided $15,000 in support of this project.
- Beginning in 2020, BRWF will complete a streambank stabilization and revegetation project on the Middle Bitterroot River at the new Skalkaho Bend Park in Hamilton. This project is anticipated to reduce water temperature and benefit aquatic life due to increased riparian shading. DEQ has provided $123,000 in support of this project.
- Instream flow leases are some of the most challenging, but potentially impactful projects to address water quality. Trout Unlimited and the Clark Fork Coalition are actively perusing instream flow projects in streams with severe flow alterations and/or priority fisheries. Numerous water leasing projects have reduced irrigation withdrawal impacts to Bitterroot tributaries such as Tin Cup Creek, Lost Horse Creek and O'Brien Creek. The Painted Rocks Reservoir water share managed by FWP has also notably improved Bitterroot River temperatures and flows.
- BRWF hosts annual irrigation tours to promote public understanding of the Valley's irrigation system. These tours typically cover reservoirs, irrigation diversions, fish screens, and agricultural applications of irrigation.

3.3 West Fork Bitterroot River

Description

The West Fork Bitterroot River is one of the largest waterbodies entering the Bitterroot River, with a drainage area of over 550 square miles. One of the most notable features of the West Fork Bitterroot River is Painted Rocks Dam, and its 32,362 acre-foot reservoir, owned by the Department of Natural Resources and Conservation. 10,000 acre-feet of this stored water is leased for irrigation while 25,000 acre-feet is marketed to Fish Wildlife and Parks and released to support instream flow in the Bitterroot River. The dam has served as a barrier to some non-native fish, making the upper West Fork one of the most valuable native fish resources in the Bitterroot. Roads, bank instability, fish passage, and historic mining are the primary impacts to the upper watershed, above Painted Rocks, and will be the focus of restoration activities, both on the West Fork and its tributaries. In the lower West Fork, restoration activities will focus on reducing the impact of the Nez Perce road to the Nez Perce Fork.

Stream Impairments[24] [25]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Complete	Source of Impairment Cause
Physical substrate habitat alterations	N/A; non-pollutant	Aquatic Life	N/A	Highway/road/bridge runoff (non-construction related) Highways, Roads, Bridges, Infrastructure (New Construction) Streambank Modifications/ destabilization
Sedimentation / Siltation	Sediment	Aquatic Life	Yes	Highways, Roads, Bridges, Infrastructure (New Construction) Streambank Modifications-destabilization Highway-Road-Bridge Runoff (Non-construction Related)
Temperature	Temperature	Aquatic Life	Yes	Not identified

[24] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana.* Department of Environmental Quality [2018]. Web.

[25] Several tributaries to the West Fork are also impaired and may be the focus of future restoration work. These include the Nez Perce Fork (Temperature), Hughes Creek (Alteration in stream-side or littoral vegetative covers; Physical substrate habitat alterations; Sedimentation/Siltation; Temperature), Overwhich Creek (Temperature), Ditch Creek (Sedimentation/Siltation) and Buck Creek (Sedimentation/Siltation).

TMDLs and Load Reductions

Sediment

West Fork Bitterroot River sediment loads are largely natural or derive from fires of 2000. Human-caused sediment loading is primarily linked to forest roads and eroding banks. A 57% decrease in sediment from forest roads is necessary, as is a 75% decrease in loads from human-caused bank erosion.[26] Sediment exceedances also occur in West Fork tributaries such as Ditch Creek (due to forest roads and silvicultural harvest), Hughes Creek (due to mining and channelization), and Buck Creek (no listed source).[27]

Temperature

The TMDL on the West Fork Bitterroot River used existing and potential shade to establish the water quality temperature goals and target. Therefore, effective shade is used as a "surrogate" measure of the temperature load reduction required to meet water quality standards. On the West Fork Bitterroot River, the majority of shade loss originates from main roads and secondary roads, and the TMDL recommends 45% effective shade to achieve the TMDL.[28] Relatively little riparian cover exists on the stretch between Deer and Hughes Creeks, making this area an opportune location for revegetation efforts.[29] Temperature exceedances also occur in tributaries, including the Nez Perce Fork (due to forest roads and loss of riparian habitat), Hughes Creek (due to mining and channelization), and Overwhich Creek (due to site clearing).[30]

Management Measures

Management measures in the West Fork will focus on reducing road-stream interaction, with potential reductions of both temperature and sediment loading. Long-term, historic mining impacts should be addressed through partnership with private landowners.

Projects

Restoration activities will focus on improving the quality and connectivity of habitat for native fish.

- Trout Unlimited is working with the Bitterroot National Forest (BNF), FWP and Bitterroot Conservation District to improve fish passage and reduce fish entrainment in ditches in the upper West Fork through diversion upgrades and fish screen installations. This effort is based on a 2017 inventory of irrigation diversions in priority Bull Trout streams. Project prioritization was based on potential benefits to native species, cost and landowner/water user willingness. These projects with private irrigators may also create opportunities for riparian restoration on private lands.
- Trout Unlimited has initiated early conversations with the Forest Service about reducing sediment and temperature loading along Nez Perce Road.
- Bitterroot National Forest actively restored mining impacts on now-public land along Hughes Creek. Eventually, this restoration should also occur on private lands, but will require buy-in from private landowners.

---

[26] Montana Department of Environmental Quality. *Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area*. 2005. Table 4-31.

[27] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana.* Department of Environmental Quality [2018]. Web.

[28] Montana Department of Environmental Quality. *Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area.* 2005. Table 5-14 and 5-15.

[29] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

[30] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana.* Department of Environmental Quality [2018]. Web.

- Between 2008 and 2010, the BNF and BRWF compiled a stream crossing inventory with $25,430 in funding from DEQ. Geum environmental consultants partnered to design three projects that addressed streambank stabilization and/or temperature impairments.
- In 2014-2015, BNF removed three culverts to eliminate fish passage barriers and seeded, fertilized, mulched, and planted native shrubs on disturbed areas.
- In 2018, BNF implemented BMPs on 8.2 miles of road adjacent to Slate Creek, a tributary to the West Fork.
- In 2016-2017, BNF planted riparian shrubs along .4 miles of stream.
- In 2016-2017, BNF implemented drainage improvements on 95 acres in the West Fork, East Fork, and Mainstem drainages. Road maintenance was performed to reduce sediment loads to streams.
- In coming years, BNF plans to implement road treatments (including BMPs, storage, and decommission) below Painted Rocks Lake. In addition, BNF plans to perform a road-to-trail conversion, including culvert removals and revegetation of disturbed soils, on a road near Overwhich Creek, a tributary to the West Fork.

3.4 East Fork Bitterroot River

Description

The East Fork of the Bitterroot River (East Fork) originates high in glaciated basins of the Sapphire Mountains. Some basins are composed of metasedimentary rocks of the Belt Series and others of granitic bedrock. Thus, glacial and alluvial deposits of mixed origins and sandy materials from granitic bedrock influence substrates of the East Fork. The East Fork flows alternately through low-gradient montane valleys and confined narrow valleys, intermittently transporting sediment and then depositing it in low-gradient reaches that run primarily through private land. The East Fork bends at its midpoint and flows north to meet the West Fork of the Bitterroot River. Below the confluence, the valley narrows, and smaller tributaries flow through moderate- to high-relief landforms, routing runoff and sediments from weathered granitic outcrops to the mainstem of the Bitterroot River. The East Fork is an important migratory corridor for Bull Trout and Westslope Cutthroat Trout coming out of the Bitterroot River to spawn and rear in the upper East Fork.

Stream Impairments[31]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Alteration in streamside or littoral cover	N/A; non-pollutant	Aquatic Life	N/A	Grazing in Riparian or Shoreline Zones Highways, Roads, Bridges, Infrastructure (New Construction), Channelization Streambank Modifications - destabilization
Sedimentation / Siltation	Sediment	Aquatic Life	Yes	Highways, Roads, Bridges, Infrastructure (New Construction) Watershed Runoff following Forest Fire Grazing in Riparian or Shoreline Zones
Temperature	Temperature	Aquatic Life	Yes	Grazing in Riparian or Shoreline Zones Streambank Modifications-destabilization Highways, Roads, Bridges, Infrastructure (New Construction) Channelization

[31] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana.* Department of Environmental Quality [2018]. Web.

TMDLs and Load Reductions

Sediment[32]

East Fork Bitterroot River sediment loads are largely natural or derive from fires of 2000. Human-caused sediment loading is primarily linked to forest roads and eroding banks. A 42% decrease in sediment from forest roads is necessary, as is a 75% decrease in loads from human-caused bank erosion.

Temperature[33]

To achieve the temperature water quality standard, the TMDL is essentially expressed as a percentage of effective shade. For this stream, 55% effective shade should cool stream temperatures sufficiently. Based on partner's priorities and landowner connections, this WRP prioritizes restoration actions aimed at increasing effective shade near the confluence of Reimel Creek and revegetation on working lands.[34]

Management Measures

Restoration actions will focus on reducing the negative effects of Highway 93 and associated development to riparian areas. Riparian revegetation will be key to achieving the TMDL's recommendations. In addition to direct impacts on streamside vegetation, these activities reduce unnatural erosion, lowering sediment rates, and provide shade and cool groundwater infiltration to lower temperatures. This lends itself well to supporting fish populations, who benefit from the improved water quality as well as improved habitat that riparian vegetation provides. Good locations for these activities include the riparian mile above the town of Conner, additional locations alongside Highway 93, and upstream of Sula. Assessing riparian roads and identifying locations where relocation could improve riparian vegetation may help achieve the desired level of shade. Where relocation is not an option, upgrading or maintaining may lower sediment delivery from near-stream roads.

Fish passage in the upper watershed is also a primary focus; additional activities may include removing barriers to fish migration or habitat use. The irrigation infrastructure on the East Fork should be considered for risks of fish entrainment in ditches and opportunities to increase instream flows. Activities on private lands may include conservation easements, improving the efficiency of irrigation systems, encouraging grazing BMPs, implement restoration projects to improve instream habitat, channel form, and riparian zones. Continued education and outreach activities will build on existing traction with private landowners in this basin.

Projects

- Between 2011 and 2016, BRWF revegetated one mile of streambank adjacent to Highway 93 to reduce temperature and sediment loads. These activities were funded in part by RAC.
- BRWF completed a project at the Lazy J Cross Ranch in Sula, MT in 2014 funded by DEQ 319, Future Fisheries Improvement Program, and Ponderosa Trust. The project included riparian cattle fencing and bank and floodplain revegetation on 5.14 acres of floodplain and 4,200 linear feet of streambank. The project addressed issues of temperature, sediment, and riparian vegetation, and reduced sediment loading by 6.6 tons/year.

---

[32] Montana Department of Environmental Quality. Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area. 2005. Table 4-20.

[33] Montana Department of Environmental Quality. Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area. 2005. Table 5-17.

[34] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

- Trout Unlimited is working with the Bitterroot National Forest, FWP and Bitterroot Conservation District to improve fish passage and reduce fish entrainment in ditches in the upper East Fork through diversion upgrades, fish screen installations, and culvert replacements.
- In 2013, Trout Unlimited and local contractors decompacted, decommissioned, and seeded 10 miles of roads in the Bertie Lord drainage. This project was supported by DEQ at $35,000, Tiffany and Company Foundation Grant and Bitterroot TU Chapter mini grant at $20,000 combined, and BNF at $18,000. This project achieved a sediment load reduction of 98 tons per year.
- In coming years, BRWF and BNF will implement South Valley Floodplain Creation, a plan to store and/or decommission sections of two roads located next to East Fork tributaries. This project is expected to cost $56,000 and will address problems with sediment, temperature, aquatic life, and streamside vegetation.
- Between 2014-2019, BNF completed approximately 42 miles of road maintenance, upgrades, storage, and/or decommission on riparian roads in East Fork drainage basin.
- In 2016-2017, BNF implemented drainage improvements on 95 acres in the West Fork, East Fork, and Mainstem drainages. Road maintenance was performed to reduce sediment loads to streams.

3.5 Cameron Creek

Description

Cameron Creek is located in the upper headwaters of the Bitterroot watershed near Sula and originates in the Sapphire Mountains on the east side of the Bitterroot Valley. It flows south through the Bitterroot National Forest and a mix of public and private land before draining into the East Fork Bitterroot River. Cameron Creek provides spawning and rearing habitat for a widely distributed population of Westslope Cutthroat Trout, which is threatened by poor habitat quality in the lower half of Cameron Creek arising from high sediment loads and elevated water temperatures. While Cameron Creek is not listed on Montana's 303(d)list of impaired waters, it is a source of elevated sediment loads and unnaturally warm water flowing into the East Fork, which itself is listed for sediment and temperature impairments. No Bull Trout permanently live in the Cameron Creek drainage; however, an incidental Bull Trout has been known to enter the lower mile of Cameron Creek to hold and feed for short periods of time (several weeks) during their upstream spawning migration in the East Fork.[35]

Stream Concerns[36]

Concern Cause	TMDL Pollutant Category	Beneficial Use of Concern	TMDL Completed	Source of Concern Cause
Temperature	Temperature	Aquatic Life	No	Shade loss (removal of riparian vegetation) Historical land use practices, including clearing and burning for agriculture Channelization Grazing in riparian or shoreline zones Streambank modifications and destabilization

TMDLs and Load Reductions

Cameron Creek does not have published TMDLs. Land use practices that remove riparian vegetation (e.g. clearing, burning, grazing, and bank modifications) have contributed to high stream temperatures through shade loss and decreased groundwater infiltration. Accordingly, riparian revegetation has a high potential for reducing temperature loads. The proportion of the stream that is most viable for restoration activities stretches from USFS 311 to its confluence with the East Fork.

---

[35] Jakober, Michael J. Cameron. Blue Ecoburn: Biological Assessment and Evaluation. Sula, MT: U.S. Forest Service, Bitterroot National Forest. 2011.

[36] Because Cameron Creek has not been assessed by DEQ, the term "impairment" does not apply. However, based on monitoring and assessment efforts completed by the Bitterroot National Forest, BRWF considers it to be a stream of concern in the Bitterroot watershed (Jakober, 2011).

Management Measures

As a warm stream that is home to a population of Westslope Cutthroat, management measures recommended for Cameron Creek include:

- Removing barriers to fish habitat use and migration, such as culverts
- Assessing the extent of dewatering in the creek and its tributaries and the associated impacts on fish and temperature
- Promote responsible irrigation and land use practices through conservation easements, education and outreach programs, grazing management plans, incentive programs
- Establish riparian vegetation to shade the stream, increase cool groundwater recharge, and improve in-stream habitat. Potential for beavery mimicry exists in the lower drainage in particular.
- Assess the locations and impacts of streamside roads; upgrade or relocate where necessary

Projects

- BRWF planted 2,500 native plants, including willow cuttings and a variety of containerized plants on Cameron Creek in 2013 and 2014. In 2016, 900 feet of coir wattles, three large woody debris structures, and additional willow cuttings were added for bank stabilization and to promote willow propagation. Approximately 10,000 feet of riparian fencing was also constructed. This project was supported by MWCC and RAC at $21,000. These plantings are anticipated to contribute to a reduction in overall stream temperatures, however, this has not been observed at the time of publication as the vegetation requires additional time to grow large enough to provide stream shade.
- In 2014, BRWF planted 2,000 plants, particularly willows, along .5 miles of Doran Creek, a tributary to Cameron Creek. These plantings were intended to revegetate barren pasture areas to help cool creek waters before entering Cameron Creek.

3.6 Rye Creek

Description

Rye Creek originates on the east side of the valley in the Sapphire Mountains and enters the Bitterroot River 6miles south of the town of Darby. Rye Creek, a 63-square-mile subwatershed, is naturally sensitive because of its geology and weathered granitic soils, which easily erode. Most of the land is public, owned by the Bitterroot National Forest, though private land comprises 15 square miles of the Rye Creek watershed. The privately owned portion has a high road density and high levels of past timber harvest; some areas show evidence of other activities, including farming, livestock grazing, and mining.

Stream Impairments[37]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Alteration in streamside or littoral vegetative covers	N/A; non-pollutant	Aquatic Life	N/A	Grazing in riparian or shoreline zones Animal feeding operations (NPS)
Nitrogen, total	Nutrients	Aquatic Life Primary Contact Recreation	Yes	Grazing in riparian or shoreline zones Animal feeding operations (NPS)
Phosphorus, total	Nutrients	Aquatic Life Primary Contact Recreation	Yes	Grazing in riparian or shoreline zones Animal feeding operations (NPS)
Sedimentation-Siltation	Sediment	Aquatic Life	Yes	Forest Roads (road construction and use) Silviculture activities

TMDLs and Load Reductions

Nutrients

To achieve the total nitrogen water quality standard, human-caused sources of nitrogen should be reduced by 20%. These sources include activities like silviculture, septic systems, and agriculture. [38] To achieve the

[37] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters.* Helena: Montana. Department of Environmental Quality [2018]. Web.

[38] Montana Department of Environmental Quality. *Final - Bitterroot Watershed Total Maximum Daily Loads and Water Quality Improvement Plan*. Document No. C05-TMDL-04aF. 2014. Table 5-41.

total phosphorus water quality standard, human-caused sources of phosphorus should be reduced by 60%. The primary source of phosphorus in Rye Creek is agriculture. [39]

For this WRP, project partners intend to focus on agricultural lands through practices such as offsite watering, fencing, and establishing riparian management corridors. This source is a priority because of landowner connections, existing momentum with these types of projects, and because nutrient pollution from these sources can be address with traditional best management practices. Septic systems may be addressed through education and outreach opportunities like realtor training and partnerships with counties and cities.

Sediment [40]

Sources of sediment in Rye Creek include animal feeding operations, grazing in riparian zones, forest roads, and silviculture. This WRP will focus on addressing sediment loads from anthropogenically influenced eroding banks (aiming for a 13% load reduction) and forest service roads (63% load reduction).

Sediment Sources		**Current Estimated Load (Tons/Year)**	**Total Allowable Load (Tons/Year)**	**Sediment Load Allocation (% Reduction)**
Roads		64	24	63%
Eroding Banks	**Anthropogenically Influenced**	621	379	13%
	Natural	1314	1314	
Upland Erosion	**All land uses**	10	7	33%
Stormwater		0	0[41]	0%
Total Sediment Load		2009	1724	14%

Management Measures

- Improve fish habitat and populations through activities such as removing passage barriers, particularly at diversion dams at irrigation ditches.
- Reduce sediment loads from roads through activities suchs as recontouring, relocating, decommissioning, and upgrading. This is of particular interest on North Rye Creek and the upper drainage.

---

[39] Montana Department of Environmental Quality. *Final - Bitterroot Watershed Total Maximum Daily Loads and Water Quality Improvement Plan,* Document No. C05-TMDL-04aF. 2014. Table 5-42.

[40] Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. 2011. Table 5-66.

[41] This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit.

- Revegetate riparian areas to reduce sediment loads from eroding banks and improve groundwater infiltration. 12,000 feet of Rye Creek offers potential for revegetation, particularly on agricultural lands and upstream of Highway 93.[42]
- Implement BMPs on agricultural lands such as livestock fencing, offsite watering, irrigation practice conversion, livestock management plans, etc.

Projects

Restoration actions here will complement restoration in the neighboring Skalkaho and Sleeping Child subwatersheds to create a large block of improved habitat for focal fish species on the eastside of the Bitterroot watershed.

- Two private landowner projects funded by DEQ were completed in 2015 addressing eroding banks. As a result of this project a total of 250 feet of streambank was restored with bioengineered soil lifts, sediment loading to Rye Creek was reduced by 100 tons, nitrogen was reduced by 21.4 pounds, and phosphorus was reduced by 173 pounds.
- BRWF and BNF completed a project in 2015 to restore streamside forest roads to their original condition, improving the riparian area and reducing sediment input to Rye Creek, Sleeping Child Creek and several tributaries. Project partners decompacted and recontoured 20 miles of roads, removed 42 culverts, and reseeded soils after treatments. Across the project area, 173 tons/year of sediment was reduced. A phase two of this project will be completed in the coming years.
- In addition to the projects done in partnership with BRWF, BNF has stored or decommissioned 185 miles of roads in the Rye Creek basin.

[42] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

3.7 Sleeping Child Creek

Description

Sleeping Child Creek is located south of Hamilton near Skalkaho Highway. Originating in the Sapphire Mountains, the creek runs for 24 miles before joining the Bitterroot River. The Creek contains fair Bull Trout and Westslope Cutthroat Trout populations, with an abundance of good spawning and rearing habitat, creating the potential for improving these populations and connecting to other population strongholds in the Bitterroot River.

Stream Impairments[43]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Sedimentation-Siltation	Sediment	Aquatic Life	Yes	Highway-road-bridge runoff (non-construction related) Agriculture Silviculture activities
Temperature	Temperature	Aquatic Life	Yes	Silviculture activities Agriculture

TMDLs and Load Reductions

Sediment[44]

The TMDL points out elevated fine sediment levels coming from roads, eroding banks due to human activities, and upland erosion. Anthropogenic effects within 100 feet of the stream were noted along 16 river miles (a third of the stream).

[43] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters.* Helena: Montana. Department of Environmental Quality [2018]. Web.

[44] Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 5-67: Sleeping Child Creek Sediment TMDL. 2011.

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (% Reduction)
Roads		31	11	63%
Eroding Banks	**Anthropogenically Influenced**	885	593	12%
	Natural	1502	1502	
Upland Erosion	**All land uses**	243	197	19%
Point Source	**Stormwater Construction**	0	3[45]	0%
Total Sediment Load		2661	2306	13%

Temperature[46]

Unnaturally warm temperatures may have developed in Sleeping Child Creek due to irrigation activities and loss of riparian vegetation. Fires of 2000 impacted vegetation along 10 miles in the middle segment of the river, and ranching and farming activities may have reduced vegetation along the lowest 7 miles of the stream. Further, in these lower reaches, irrigation diversions reduce streamflow in the river, allowing it to be heated more easily by the sun. Decreasing Sleeping Child Creek's high temperatures is important to make the stream more suitable for native trout over Brown Trout. The TMDL recommends the following measures to achieve a 1F decrease in maximum temperature:

- Increase shade to cover 2% more of the river;
- Decrease the channel width: depth ratio from 24.6 to 16 or less;
- Improve irrigation efficiencies in order to
    - Reduce the amount of water withdrawn for irrigation by 15%, particularly in the summer
    - Reduce the amount of irrigation water that is returned to the stream by 75%

Management Measures

Approaches to reduce temperature and sediment loads and benefit aquatic life include:

- Reducing the impacts of streamside roads through redesign, relocation, upgrades, etc. One road that may be a target is located on the north side of the stream.
- Remove barriers to Bull Trout and other species' passage. One diversion dam has been identified as a possible problem.

[45] This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than the amount given in this table.
[46] Montana Department of Environmental Quality. Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan, Document No. C05-TMDL-03aF. 6.5.5. 2011.

- Revegetating riparian areas to increase shade and reduce sediment loads. Approximately 9,000 feet of easily-implemented revegetation potential exists, mostly on farming/ranching lands.[47] Revegetation is particularly needed in middle and lower reaches of the stream, though subdevelopments and presence of homes will require landowner buy in.
- Improving irrigation efficiencies. Activities include encouraging landowners to convert their irrigation practices and implement BMPs, upgrading irrigation infrastructure (e.g. ditch lining, headgate installation), and monitoring and metering flows.

Projects

Restoration activities will focus on improvements that could enhance the populations and migratory capacity of native trout.

- BRWF and BNF completed a project in 2015 to restore streamside forest roads to their original condition, improving the riparian area and reducing sediment input to Rye Creek, Sleeping Child Creek and several tributaries. Project partners decompacted and recontoured 20 miles of roads, removed 42 culverts, and reseeded soils after treatments. Across the project area, 173 tons/year of sediment was reduced. A phase two of this project will be completed in the coming years.

[47] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

3.8 Skalkaho Creek

Description

The Skalkaho Creek drainage is a large subwatershed of approximately 132 square miles. Originating high in the Sapphire Mountains, Skalkaho Creek flows nearly 28 miles west-northwest through agricultural lands and smaller private parcels before reaching the Bitterroot River. On portions of Bitterroot National Forest land, Skalkaho Creek contains healthy populations of Bull Trout and Westslope Cutthroat Trout; indeed, Skalkaho Creek contains some of the highest densities of Bull and Westslope Cutthroat in the BNF. The pure-strain bull trout population and quality habitat make Skalkaho a highly important for population maintenance. However, on downstream private lands, native trout diminish and exotic trout (Brook, Brown, and Rainbow) increase. According to the Subbasin plan, the Upper Skalkaho Creek is "a native fish stronghold and supports the best Bull Trout and Westslope Cutthroat Trout populations on the eastside of the Subbasin."[48] Four miles of Skalkaho Creek are considered chronically dewatered.[49]

Stream Impairments[50]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Flow Regime Modification	N/A; non-pollutant	Aquatic Life	N/A	Crop production (irrigated)

TMDLs and Load Reductions

TMDLs are not applicable to flow regime modification impairments, and therefore load reductions are not calculated for Skalkaho Creek. The important native fishery is at risk from dewatering, grazing, passage barriers, loss of riparian vegetation, and exotic trout.[51] The stream is chronically dewatered for four miles and particularly between the Ward and the Republican irrigation diversions. Additionally, stream channel sections that have been historically straightened to make way for agriculture or other development can contribute to dewatering because channel complexity slows water movement over the landscape. Accordingly, addressing irrigation inefficiencies and improving water storage on the landscape are important restoration opportunities on Skalkaho Creek.

Management Measures

To address flow regime modification and assist aquatic populations in Skalkaho Creek, management measures should focus on:

[48] Bitterroot Subbasin Plan for Fish & Wildlife Conservation p.38

[49] (FWP, 2005)

[50] Montana Department of Environmental Quality. Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana. Department of Environmental Quality [2018]. Web.

[51] Montana DEQ. Water Quality Standards Attainment Record. 23 Jan. 2018. Assessment Record: MT76H004_100.

- Improving fish populations by identifying and removing barriers to migration or habitat use and eliminating fish entrainment in irrigation ditches, particularly with respect to Bull Trout. Ditch crossings upstream of Highway 93 may warrant further exploration.
- Improving instream flows by encouraging responsible land use practices. This may include:
    - Purchasing water rights
    - Encouraging irrigation system conversion to efficient setups
    - Conservation easements
    - Education and outreach
- Improving landscape water storage by protecting and enhancing riparian habitats. Strategies to achieve this include:
    - Implementing grazing BMPs in riparian areas
    - Revegetation and floodplain creation activities, including native plant reintroduction, beaver dam analogue construction, and vegetation-based streambank stabilization. Approximately 10,000 feet of easily-implemented revegetation potential exists, particularly on lower reaches and on grazing or agricultural lands.[52]
    - Recountouring or relocating streamside roads
    - Channelized areas near Meadowlark Lane may warrant further exploration
- Reduce the propensity of other water quality issues (sediment, temperature, etc.) to develop. (Roads adjacent to Daly and Skalkaho Creek, including road 75, contribute large amounts of sediment to the stream and may require redesign or maintenance. Both Upper Skalkaho and Daly Creek have recently been burned at moderate to high severity.)

Projects

Restoration actions will provide potential for expanding habitat for native species strongholds in the upper reaches of Skalkaho Creek, and improving habitat connectivity in the lower reaches.

- In 2016-2017, BNF replaced two culverts to accommodate 100-year flows and aquatic organism passage.
- In 2015, BNF improved 1.1 miles of streambank along Daly Creek, stabilized stream banks along Railroad Creek, and implemented measures to control recreational access along Railroad, Hog Trough, and Upper Skalkaho Creeks.
- Due to time constraints and capacity limitations, BRWF has not completed any projects on Skalkaho Creek to date, nor are any specific projects currently planned. Due to the stream's impairment status and cultural significance, opportunities for restoration will continue to be sought through networking and outreach.

[52] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

3.9 Willow Creek

Description

Willow Creek originates in the Sapphire Mountains on the eastern side of the Bitterroot Valley and supports strong native trout populations in its upper reaches. It flows mostly through private lands and stretches for 20 miles. Willow Creek empties into the Bitterroot River near Corvallis.

Stream Impairments

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Alteration in streamside or littoral vegetative covers	N/A; non-pollutant	Aquatic Life	N/A	Crop production (irrigated) Silviculture activities Loss of riparian habitat
Sedimentation/ Siltation	Sediment	Aquatic Life	YES	Silviculture activities Loss of riparian habitat
Temperature	Temperature	Aquatic Life	YES	Water diversions Crop production (irrigated) Loss of riparian habitat

TMDLs and Load Reductions

Sediment[53]

Roads, anthropogenically influenced streambank erosion, and upland erosion have resulted in elevated sediment loads in Willow Creek. Riparian grazing and agriculture are the biggest causes of bank erosion. Improving riparian conditions using BMPs can reduce this bank erosion and also reduce upland sediment loads. BMPs can also reduce sediment loads from roads.

53 Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 5-70: Willow Creek Sediment TMDL. 2011.

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (% Reduction)
Roads		15	5	66%
Eroding Banks	**Anthropogenically Influenced**	922	461	27%
	Natural	783	783	
Upland Erosion	**All land uses**	621	394	37%
Point Source	**Stormwater Construction**	0	11*	0%
Total Sediment Load		2341	1654	29%

*This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than this amount.

Temperature[54]

High temperatures in Willow Creek may have been caused by reduced riparian vegetation (especially on grazing/crop lands on the lower seven miles of the stream; many areas have less than 25% riparian cover[55]). Water is also diverted for irrigation in the lower half of the watershed, which results in temperature rise of the remaining streamflow. The Republican and Hedge ditches cross and mix with the Creek, which may result in warmed water.

The following practices are recommended to reduce the maximum stream temperature by 2.5F:

- Create effective shade on 8% more of the river (8% represents restoring riparian conditions to their natural state)
- Study and alter irrigation management practices to produce maximum benefit for the fishery
- 15% improvement in irrigation efficiency

Management Measures

To increase streamside vegetative cover and reduce sediment and temperature loads in Willow Creek, the following measures are recommended.

[54] Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 6-24. 2011.

[55] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

- Outreach and education programs targeting landowners in the Willow Creek drainage that encourage responsible land use and irrigation practices
- Riparian revegetation to increase shade and decrease sediment loads, especially on the lower half of the stream. Approximately 90,000 feet of readily-achievable revegetation potential exists on Willow Creek, particularly on crop or grazing lands[56]
- Restoration activities that promote channel complexity (large woody debris, beaver mimicry, bank bioengineering) especially in channelized areas
- Implementing upland and riparian agricultural BMPs to reduce sediment delivery
- Road BMPs (ditch relief at crossings, water bars, vegetative buffers, maintenance, recontouring) on streamside roads and crossing to reduce sediment loads
- Studying irrigation practices and infrastructure in the area to determine opportunities for improving irrigation efficiency and reducing withdrawals

Projects

- In coming years, BNF will complete Gold Butterfly Project to reduce fuels and implement BMPs, store, or decommission roads, particularly in riparian areas. This project will reduce sediment loads in Willow Creek and Burnt Fork Creeks.
- In 2016-2017, BNF improved 3.5 miles of roads in the Willow Creek drainage.
- Due to time constraints and capacity limitations, BRWF has not completed any projects on Willow Creek to date, nor are any specific projects currently planned. Due to the stream's impairment status and cultural significance, opportunities for restoration will continue to be sought through targeted networking and outreach.

[56] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

3.10 North Burnt Fork Creek

Description

This subwatershed is 85.9 square miles, making it one of the largest tributaries on the east side. Its north-facing headwaters maintain cold water that is home to a strong resident Bull Trout and Cutthroat Trout population. The drainage as a whole supports a diversity of migratory birds, waterfowl species, and is a key migration corridor for terrestrial species. After leaving Forest Service property in the headwaters, Burnt Fork Creek runs through active agricultural land. The lower three miles of Burnt Fork Creek meander through the scenic Lee Metcalf Wildlife Refuge, which provides spectacular fishing, hunting, bird-watching, wildlife viewing, and hiking opportunities, drawing both local recreationists and out-of-state visitors to western Montana. The lower 5 miles of the Burnt Fork is considered chronically dewatered and disconnects from the Bitterroot River at low flows most years.[57]

Stream Impairments[58]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Nitrogen, total	Nutrients	Aquatic Life Primary Contact Recreation	YES	Grazing in riparian or shoreline zones Crop production (irrigated)
Phosphorus, total	Nutrients	Aquatic Life Primary Contact Recreation	YES	Grazing in riparian or shoreline zones Crop production (irrigated)
Sedimentation - Siltation	Sediment	Aquatic Life	YES	Grazing in riparian or shoreline zones Crop production (irrigated)

TMDLs and Load Reductions

Nutrients

To achieve the total nitrogen water quality standard, human-caused sources of nitrogen should be reduced by 40% and phosphorus by 20%. These sources are primarily agriculture.[59] For this WRP, project partners intend to focus on agricultural lands through practices such as offsite watering, fencing, and establishing riparian management corridors. This source is a priority because of landowner connections, existing momentum with these types of projects, and because nutrient pollution from these sources can be

[57] (FWP, 2005)

[58] Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters.* Helena: Montana. Department of Environmental Quality [2018]. Web.

[59] Montana Department of Environmental Quality. *Final - Bitterroot Watershed Total Maximum Daily Loads and Water Quality Improvement Plan.* Helena: Montana. Department of Environmental Quality [2014]. Document No. C05-TMDL-03aF. Table 5-34 and 5-35. Print.

addressed with traditional best management practices. Septic systems near the creek also contribute nutrients; this source could be addressed through partnerships with cities and counties.

Sediment[60]

More than 90% of North Burnt Fork Creek is identified in the TMDL as in fair or poor condition. Land use practices are likely the cause of degradation, particularly agricultural activities such as hay production and grazing near the stream.

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (% Reduction)
Roads		21	8	62%
Eroding Banks	**Anthropogenically Influenced**	2070	952	41%
	Natural	656	656	
Upland Erosion	**All land uses**	2279	1195	48%
Point Source	**Stormwater Construction**	0	19[61]	0%
Total Sediment Load		5026	2830	44%

Management Measures

- Riparian revegetation activities are highly recommended. These can reduce sediment loads and benefit aquatic habitat. In turn, levels of nutrients that adsorb to sediments will be reduced. 50,000 feet of easily achievable revegetation potential exists, especially on farming and ranching lands.[62] Particular locations include west of the railroad crossing and upstream of the Eastside Highway.
- Removing barriers to connectivity (e.g. at Big Ditch Crossing, Lee Metcalf Wildlife Refuge)
- Implementing channel complexity projects to create habitat for important fish species
- Building on current traction in the basin with education, outreach, and collaboration between groups
- Reducing sediment loads from roads by implementing BMPs
- Exploring opportunities to upgrade or relocate septic systems near the stream

60 Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 5-65: North Burnt Fork Creek Sediment TMDL. 2011.

61 This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than the amount given in this table.

62 Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

- Encouraging responsible land use practices and implementation of BMPs, particularly establishing riparian management zones on farms and ranches. This can be achieved for example, through incentive programs or conservation easements.
- Improve irrigation efficiencies through encouraging efficient practices and infrastructure upgrades

Projects

Restoration activities include reducing sediment, nutrient and irrigation impacts to the stream and improving fish passage.

- In 2011, Trout Unlimited installed 1-mile of fence, 3 cattle crossings and hundreds of riparian plants on a private cattle ranch approximately 3 miles upstream of the Burnt Fork-Bitterroot confluence. These efforts have resulted in substantial cottonwood growth, shading the stream and reducing streambank erosion.
- Trout Unlimited is currently working with the Supply Ditch Association and Lee Metcalf Wildlife Refuge to assess the feasibility of several projects to reduce temperature and nutrient loading in the lower Burnt Fork, and improve fish passage. This includes leading intensive temperature, flow and nutrient monitoring, developing conceptual plans and convening stakeholder meetings.
- The Bitter Root Land Trust has set up several conservation easements with landowners in the North Burnt Fork drainage basin.
- Beginning in 2019, BRWF has been developing riparian fencing, revegetation, and bank stabilization projects with at least one landowner on North Burnt Fork Creek. This work is anticipated to reduce sediment and nutrient loads in the stream and has been provided $57,000 by DEQ and $5,000 by Friends of Lee Metcalf.
- BNF improved, stored, or decommissioned 9.5 miles in the Threemile and Lower Burnt Fork basins 2014-2015.
- In coming years, BNF will complete the Gold Butterfly Project to reduce fuels and implement BMPs, store, or decommission roads, particularly in riparian areas. This project will reduce sediment loads in Willow Creek and Burnt Fork Creeks.

3.11 Threemile Creek

Description

Threemile Creek flows in northeast Ravalli County, originating in the Sapphire Mountains and flowing in a general westward direction through a mixture of public and private land for 12 miles before entering the Lee Metcalf Wildlife Refuge and joining the Bitterroot River north of Stevensville. Upper Threemile Creek drains into the Threemile Wildlife Management Area managed by Montana Fish, Wildlife& Parks. In the late 1990s, the Ravalli County Sanitarian's Office conducted a study of NPS pollution issues within 10 priority subwatersheds of the Bitterroot River and ranked Threemile Creek highest in concentration of nutrients and lowest in aquatic habitat quality and biological integrity.[63]

Stream Impairments[64]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Flow Regime Modification	N/A; non-pollutant	Aquatic Life	N/A	Agriculture Crop production (irrigated)
Nitrate-Nitrite	Nutrients	Aquatic Life Primary Contact Recreation	Yes	Agriculture
Nitrogen, total	Nutrients	Aquatic Life Primary Contact Recreation	Yes	Agriculture
Phosphorus, total	Nutrients	Aquatic Life Primary Contact Recreation	Yes	Agriculture
Sedimentation - Siltation	Sediment	Aquatic Life	Yes	Agriculture Rangeland grazing

TMDLs and Load Reductions

Nutrients

To achieve the total nitrogen water quality standard, human-caused sources of nitrogen should be reduced by 68% and phosphorus by 79%. These sources are primarily agriculture.[65] For this WRP, project partners intend to focus on agricultural lands through practices such as offsite watering, fencing, and establishing

63 McDowell, Will and Jim Rokosch. Ambrose Threemile Watershed Project: Watershed Assessment and Recommendations for Stream Improvements. 2005.

64 Montana Department of Environmental Quality. *Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters.* Helena: Montana. Department of Environmental Quality [2018]. Web.

65 Montana Department of Environmental Quality. *Final - Bitterroot Watershed Total Maximum Daily Loads and Water Quality Improvement Plan.* Helena: Montana. Department of Environmental Quality [2014]. Document No. C05-TMDL-03aF. Table 5-28 and 5-29. Print.

riparian management corridors. This source is a priority because of landowner connections, existing momentum with these types of projects, and because nutrient pollution from these sources can be addressed with traditional best management practices. Septic systems near the creek also contribute nutrients, particularly nitrogen; this source could be addressed through partnerships with cities and counties.

Sediment[66]

Anthropogenically-caused eroding banks and upland erosion due to land use are major sources of excessive sediment. Agricultural activities, such as crop production and rangeland grazing, are primary causes; near-stream roads also contribute sediment.

Sediment Sources		**Current Estimated Load (Tons/Year)**	**Total Allowable Load (Tons/Year)**	**Sediment Load Allocation (% Reduction)**
Roads		22	7	67%
Eroding Banks	**Anthropogenically Influenced**	2288	1098	35%
	Natural	1082	1082	
Upland Erosion	**All land uses**	1384	836	40%
Point Source	**Stormwater Construction**	0	11[67]	0%
Total Sediment Load		4776	3034	36%

Management Measures

- Outreach and education programs targeting landowners in the Threemile Creek drainage that encourage responsible land use and irrigation practices
- Riparian revegetation to decrease sediment loads, especially on entrenched, exposed banks and bare ground. Approximately 20,000 feet of readily-achievable revegetation potential exists, particularly on crop or grazing lands.[68]
- Restoration activities that promote channel complexity and improve habitat (large woody debris, beaver mimicry, bank bioengineering) especially in channelized areas. This is particularly necessary in Wheelbarrow Creek and lower Ambrose Creek.[69]

---

66 Montana Department of Environmental Quality. Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan, Document No. C05-TMDL-03aF. Table 5-69. 2011.

67 This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit. Full compliance with all conditions of the permit should achieve a load less than the amount given in this table.

68 Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

- Implementing upland and riparian agricultural BMPs to reduce sediment delivery
- Road BMPs (ditch relief at crossings, water bars, vegetative buffers, maintenance, recontouring) on streamside roads and crossing to reduce sediment loads. Culvert replacements may also be necessary, for example, on Ambrose Creek Road.
- Studying irrigation practices and infrastructure in the area to determine opportunities for improving irrigation efficiency and reducing withdrawals.

Projects

Restoration activities will focus on measures that reduce sediment delivery to the stream.

- In 2012, BRWF completed a $15,000 project which involved road resurfacing and culvert installation with the intention of reducing sediment load to Threemile Creek.
- In 2020, BRWF and FWP will complete an infrastructure improvement project on Wheelbarrow Creek, a tributary to Threemile Creek. This project includes the replacement of an undersized perched culvert and implementing 1.7 miles of road BMPs surrounding the stream crossing. Further, log weirs will be constructed to facilitate the passage of Westslope Cutthroat Trout under the new bridge. This project is supported by DEQ at $40,000, FWP at $20,000, and Future Fisheries Improvement Program (FFI) at $20,000. By improving habitat and reducing sediment loads in Wheelbarrow Creek, this project also fulfills priorities outlines in the 2005 Ambrose Threemile Watershed Assessment.[70]
- BNF improved, stored, or decommissioned 9.5 miles in the Threemile and Lower Burnt Fork basins 2014-2015.
- In 2020, BNF and FWP will complete a forest habitat improvement project in the Threemile Wildlife Management Area under the Good Neighbor Authority which will include revegetation, fuels reduction, and road BMPs, and will likely reduce sediment loads to Threemile Creek.
- Threemile Creek has also been a focus of restoration activities for Clark Fork Coalition.

[69] McDowell, Will and Jim Rokosch. Ambrose Threemile Watershed Project: Watershed Assessment and Recommendations for Stream Improvements. 2005.

[70] McDowell, Will and Jim Rokosch. Ambrose Threemile Watershed Project: Watershed Assessment and Recommendations for Stream Improvements. 2005.

3.12 Miller Creek

Description

Miller Creek is located in the Missoula metropolitan area and drains into the Lower Mainstem Bitterroot River. For in depth information on Miller Creek, please see the Miller Creek Watershed Restoration Plan.

Stream Impairments[71]

Impairment Cause	TMDL Pollutant Category	Impaired Beneficial Use	TMDL Completed	Source of Impairment Cause
Alteration in stream-side or littoral vegetative cover	N/A; non-pollutant	Aquatic Life	N/A	Grazing in riparian or shoreline zones Silviculture activities Loss of riparian habitat Crop production (crop land or dry land)
Sedimentation-Siltation	Sediment	Aquatic Life	Yes	Loss of habitat Grazing in riparian or shoreline zones Silviculture activities
Temperature	Temperature	Aquatic Life	Yes	Loss of habitat Grazing in riparian or shoreline zones Silviculture activities

TMDLs and Load Reductions

Sediment[72]

Degraded in-stream and riparian habitats as well as elevated sediment loads may have been caused by silviculture, forest roads, agriculture, and suburban developments. Streambank erosion caused by human activity is a major source of elevated sediment.

71 Montana Department of Environmental Quality. Final 2018 Water Quality Integrated Report Appendix A: Impaired Waters. Helena: Montana. Department of Environmental Quality [2018]. Web.

72 Montana Department of Environmental Quality. Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan, Document No. C05-TMDL-03aF. Table 5-63: Miller Creek Sediment TMDL. 2011.

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Sediment Load Allocation (% Reduction)
Roads		27	10	63%
Eroding Banks	**Anthropogenically Influenced**	1415	792	30%
	Natural	659	659	
Upland Erosion	**All land uses**	131	77	41%
Stormwater		0	0*	0%
Total Sediment Load		2232	1538	31%

* This allocation represents the maximum allowable load under the constraints of the current Stormwater Construction permit.

Temperature [73]

Temperatures in Miller Creek are unsuitable for native trout. The following criteria should be reached to achieve an 8F decrease in maximum daily temperature:

- Establish effective shade on 17% more of the creek (this 17% would correspond to a return to the creek's natural amount of shade). Shade loss was caused by timber, agricultural and suburban lawn care activities.
- Reduction of channel width: depth ratio from up to 48 at present to 16 or less.
- Increase irrigation efficiency by 15% to reduce water withdrawals in warm months. The lower stream, particularly below Trails End Road, experiences severe dewatering and is disconnected during periods of maximum withdrawal.
- Reduce irrigation water that is returned to the stream by 75%.

Management Measures

- Implement riparian revegetation projects. Multiple reaches have less than 25% riparian cover. Notably, there is easily-attainable revegetation potential on approximately 100,000 feet of stream.[74] Riparian vegetation will shade the stream and reduce sediment from upland and bank erosion. It will also improve water storage and groundwater infiltration to help maintain flows despite irrigation withdrawals. Riparian buffers to facilitate vegetation growth can be established on agricultural and suburban properties.

[73] Montana Department of Environmental Quality. *Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan*, Document No. C05-TMDL-03aF. Table 6-15. 2011.

[74] Montana DEQ Watershed Protection Section. "Riparian Evaluation and Wetland Priorities Results." June 2019.

- Study the irrigation system to determine where efficiencies can be improved. Encourage responsible water use practices through education and outreach activities and upgrade irrigation infrastructure.
- Implement BMPs at streamside roads and crossings
- Encourage land use BMPs on agricultural lands (e.g. offsite watering, fencing, etc.)

Projects

Restoration activities on Miller Creek will focus on revegetating riparian areas to reduce sediment loads to the stream and provide shade.

- As of 2018, BRWF is working on a $65,000 riparian fencing and revegetation project on a cattle ranch on Miller Creek with support from DEQ, MWCC, and TU. The project will protect and restore 0.6 miles of stream, and is expected to reduce sediment loads by 19 tons/year. As vegetation grows in, temperature loading will also decrease.
- Miller Creek has also been an area of focus for Clark Fork Coalition.

3.13 Pattee Creek

Description

Pattee Creek originates in the Pattee Canyon Recreation Area of the Lolo National Forest east of Missoula and southeast of the confluence of the Bitterroot and Clark Fork Rivers. Pattee Creek flows west out of the recreation area, through small agricultural fields used for often intense grazing, past an active gravel pit and through residential neighborhoods. Prior to entering the Missoula Valley, Pattee Creek goes through a stormwater detention pond and then alternates between being piped underground and flowing through ditches before entering the Bitterroot River. Although Pattee Creek is not on the 303(d) list of impaired waters, there is direct year-round discharge to the Bitterroot River. Missoula Valley Water Quality District sampling in March 2019 indicates Pattee Creek contributes to Bitterroot River impairments as Total Suspended Solids measurements at the headwaters site were measured at non-detect while discharge at the mouth measured at 282 mg/L. For reference, the benchmark value for TSS in stormwater permits 100 mg/L.

Figure 10. Pattee Creek Confluence with the Bitterroot River March 2019.

Figure 11: Pattee Creek channelized through residential development

Stream Concerns[75]

Concern Cause	TMDL Pollutant Category	Beneficial Use of Concern	TMDL Completed	Source of Concern Cause
Temperature	Temperature	Aquatic Life	No	Shade loss (removal of riparian vegetation) Channelization Streambank modifications and destabilization
Sedimentation-Siltation	Sediment	Aquatic Life	No	Road runoff (non-construction related)
Alteration in streamside or littoral vegetative covers	N/A; non-pollutant	Aquatic Life	N/A	Mowing in riparian zones Alteration of streamside vegetation

[75] Because Pattee Creek has not been assessed by DEQ, the term "impairment" does not apply. However, based on monitoring and assessment efforts completed by the Missoula Valley Water Quality District, MVWQD considers it to be a stream of concern in the Bitterroot watershed (EQUIS 2019).

TMDLs and Load Reductions

Pattee Creek does not have published TMDLs.

Management Measures

Restoration actions will include replacing undersized culverts, increasing riparian revegetation, mitigating agricultural impacts of grazing, decreasing road impacts, and decreasing residential irrigation withdrawals. Long-term, Pattee Creek should be daylighted, removed from pipes underground, and restored to natural function. Continued management of aquatic and streamside invasive species will be important to restoration of riparian vegetation.

Projects

- Partner with the City of Missoula Parks and Recreation Department to restore riparian vegetation and create educational examples of a healthy riparian corridor
- Decrease impairments caused by road maintenance activities on Pattee Creek through revegetation efforts, increasing culvert size or installing bridges or bottomless culverts and developing management plans with the City Roads Department and the USFS
- Work with landowners to decrease impacts associated with agricultural practices, such as grazing management and riparian fencing.
- Work with the City of Missoula Stormwater, Development Services, and Public Works Departments to daylight sections of Pattee creek that are currently being treated as stormwater
- Promote green instead of gray stormwater treatment
- Decrease withdrawals from Pattee Creek in residential areas for watering purposes through education regarding water rights and the lower rates for irrigation water available through Missoula Water
- Develop outreach to landowners to improve riparian corridor in residential areas

3.14 O'Brien Creek

Description

The O'Brien Creek watershed (Figure 12) encompasses 25.4 square miles and is the last major tributary to the Bitterroot River before its confluence with the Clark Fork River. Flowing east, O'Brien Creek is in the Northern Bitterroots, originating on the east face of the Grave Creek sub-range through low-gradient montane valleys and confined narrow valleys with very few depositional reaches. Primary geology is of the Belt Supergroup.

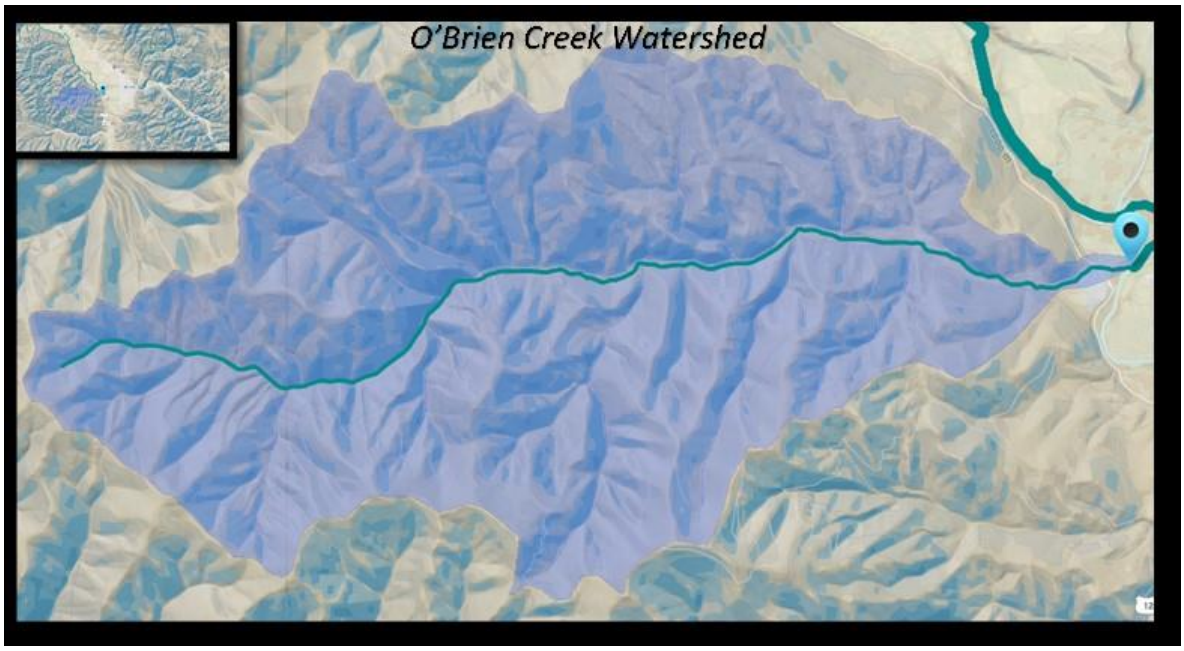


Figure 13: O'Brien Creek watershed flowing east to confluence with the Lower Bitterroot River

Land ownership in the watershed is a mix of Forest Service, Private and Weyerhaeuser ownership (78%, 20%, and 2%, respectively). The upper watershed is predominately public, USFS, land with the lower watershed occupied by private, small parcels. Several sections of the mid and upper watershed were formally private industrial forest land (i.e. Owens and Hurst, later Champion, then Plum Creek) and within the last 20-30 years have become USFS lands through exchanges aimed to swap like properties and eliminate the higher complexity, checker-board ownership pattern established in the late 1800s. Another quarter-section of private land was donated to the USFS.

O'Brien Creek and watershed have experienced heavy uses since the late 1800s. Unpublished historic records note early homesteading, tick epidemics (i.e. large "tick vat", excavated pit, carved near the creek as a treatment facility presumably for deer), at least two grain mills (one large mill at the confluence of O'Brien Creek and the Bitterroot River), miles of diversion, channelization, and manipulation (Crawford, 2019). At least historic one rail line, providing logs to Missoula, extended approximately 11-12 miles up the drainage with remnants still existing (Crawford, 2019). In the lower watershed, O'Brien Creek unnaturally went dry for years because of diversion manipulation and withdrawals; however, with recent awareness and senior water right purchase and management by the Clark Fork Coalition, Obrien Creek now flows perennially in all reaches. Current private use is multiple land parcels and varying conditions from heavily grazed and encroached to actively healing riparian vegetation and stream conditions.

General stream reconnaissance reveals obvious signs of instability (highly variable channel dimensions, lack of floodplain connection, bank erosion and at least two incision trends with new active channel forming at lower elevation, lack of wood and energy dissipation, lack of pool habitat, lack of riparian vegetation and recruitable wood, etc.)

Approximately 2668 acres (21%) of Forest Service land has been harvested. The watershed has a moderately dense road network (5.17 mi road per mi^2). O'Brien Creek has 6.2 miles of riparian road along 10.3 miles of its mainstem with significant lengths with active road fill erosion (i.e. 60% with road within 200 ft. of the stream, with many segments within 50-100 ft). There are at least two segments at the upper end of the mainstem road length where the stream has captured the old road/rail bed. There are a total of 112 road-stream crossings in the watershed; six are on the mainstem. It is presumed that several are total or partial barriers to upstream fish movement.

In the mid-1990s, the Lolo National Forest exercised a substantive road decommissioning effort on acquired private industry roads not necessary for the long-term transportation system and land management plans. This effort recontoured dozens of road miles on the former industry lands where the timber resource had extensively been utilized. This action eliminated several non-point source sediment delivery sources from undersized road-stream crossings and returned many hillslopes to natural recovery and vegetation reproduction. Some remaining roads and deferred maintenance continue to create impacts.

A very cold tributary, O'Brien Creek is one of the most important tributaries in the lower Bitterroot for rainbow and cutthroat trout (MT FWP, 2019). Table 14 highlights 2018 and 2019 data, accompanied by Figure 15, displaying 2019 thermograph readings.[76]

	Temperature (Fahrenheit)		
Date	Average	Maximum	Minimum
2018	52	60	41
2019	51	63	33

Table 14. 2019 Late Season Stream Temperature Monitoring Results

[76] Clark Fork Coalition, 2019.

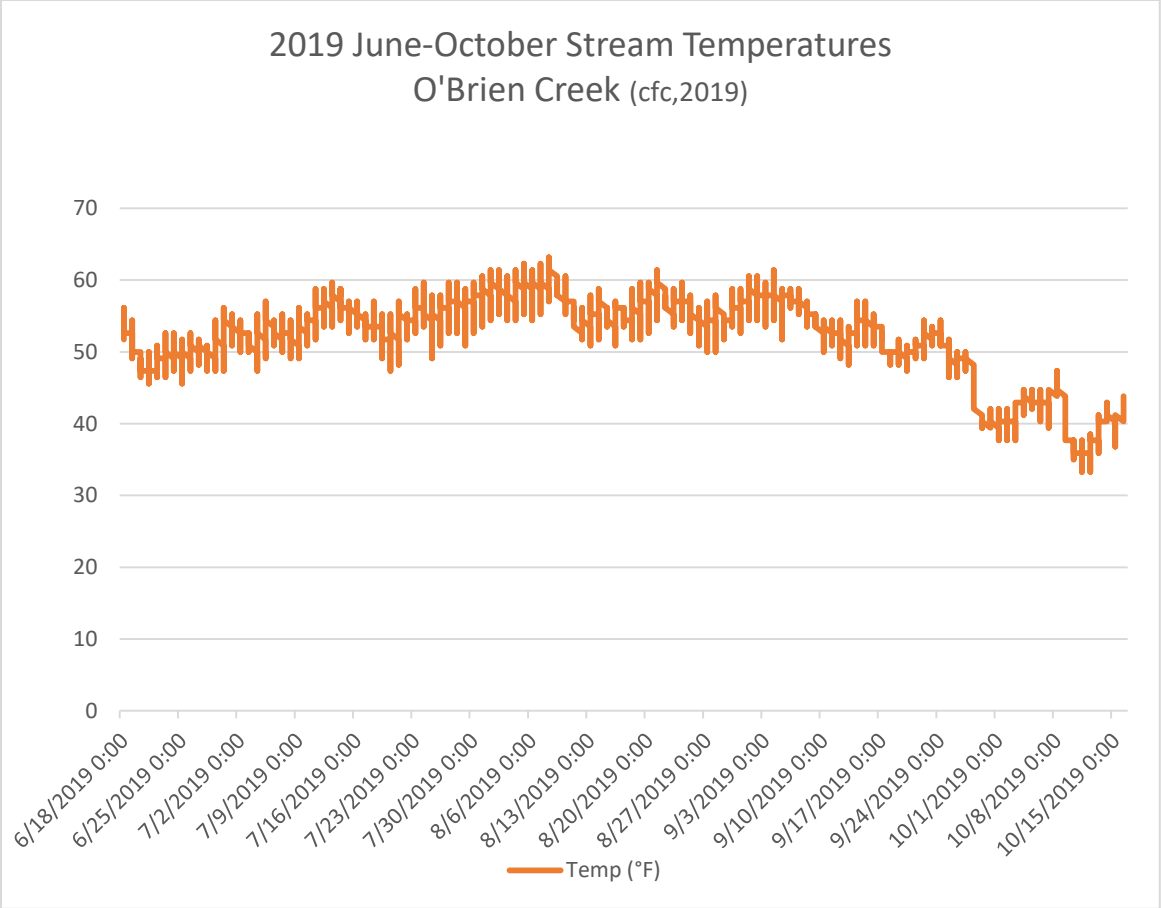


Figure 15: Late Season Stream Temperatures below Blue Mountain Road

Large portions (39%) of the watershed has experienced relatively recent wildfire. The 2003 Black Mountain fire burned 6222 acres, predominately on Forest Service, but some on private land in the lower watershed. Current wildfire risk remains very high. The Lolo National Forest, Missoula Ranger District, is heavily engaged in planning efforts to conduct prescribed fire and vegetation management aimed to create landscape conditions more similar to natural wildfire regimes where feasible (Wildfire Adapted Missoula, WAM, USFS, 2019).

Stream Concerns

The following stream concerns are based on a compendium of observations and data collected. Please see Appendix A for detailed information.

Concern Cause	TMDL Pollutant Category	Beneficial Use of Concern	TMDL Complete	Source of Concern Cause
Sedimentation-Siltation	Sediment	Aquatic Life	No	Streambank erosion, road runoff, Channelization/entrenchment; Streambank modifications and destabilization; instream wood removal;
Alteration in streamside or littoral vegetative covers	Non-pollutant	Aquatic Life	N/A	Mowing in riparian zones Alteration of streamside vegetation

TMDLs and Load Reductions

Although O'Brien Creek does not have an established TMDL, the 2011 Bitterroot TMDL includes sediment loading data from unpaved road networks, including road crossings and parallel road segments (11.98 tons/year and 10.72 tons/year, respectively). Sediment delivery from road surface sediment, road fill failure, stream bank erosion, and other sources has not been quantified; however it is very likely that non-point source delivery is at least 1-2 orders of magnitude above natural background levels. Further investigation is necessary to quantify. Immediate rehabilitation of O'Brien Creek to arrest sediment sources and establish proper fluvial geomorphic and riparian vegetation conditions is highly warranted to address sediment loading that unequivocally is producing excessive sediment contributions to the Lower Bitterroot River.

Management Measures

The following management measures are recommended to address O'Brien Creek's sediment loads as well as benefit impaired aquatic life in the stream:

- Establishing stable stream and floodplain morphology in unstable, entrenched, and/or erosive reaches
- Removing or replacing culverts
- Relocating roads away from floodplain and riparian zones
- Returning roads to a natural state
- Implementing BMPs on roads in floodplain and riparian areas
- Promoting fish and wildlife habitat protection
- Implementing measures that encourage natural flood control, erosion control, and groundwater recharge. Strategies include riparian revegetation, beaver dam analogues, and vegetation-based streambank stabilization
- Restoring aquatic habitat diversity
- Removing barriers to fish migration and habitat use
- Expanding education and outreach programs

Projects

- In approximately 1998, Missoula County replaced an undersized culvert at the Blue Mountain Road crossing. This culvert was a fish barrier.
- In approximately 1999, FWP and Water Consulting, Inc. completed a stream channel stabilization and habitat enhancement project in the confluence reach of O'Brien Creek.
- In 2017, Missoula County and Watershed Consulting planted a streamside area to mitigate for flood impacts.
- In 2019, the O'Brien Creek HOA funded remediation at a stream avulsion site and provided temporary base protection at a mass failure site. 11 large trees were donated by Hillsdale Estates.

Please see appendix A for detailed information on restoration projects on O'Brien Creek.

3.15 Tributaries

Tributaries directly contribute to the health of priority streams. Because BRWF is focusing on the overall health of each of the subwatersheds listed in this WRP, we will also consider addressing pollutants, implementing restoration projects, and conducting education and outreach on degraded tributaries to priority streams. Beyond addressing existing pollutants and degraded locations, BRWF will also explore opportunities for preventative measures, that is, restoration activities that can reduce the likelihood of impairments from developing in the future. This technique will be applied to priority streams as well as to their tributaries.

Projects

- Between 2008 and 2011, Ravalli County Environmental Health updated the City of Hamilton's Source Water Protection Plan, which included water quality sampling of domestic wells, hosted a hazardous waste disposal event, and distributed 419 $75 coupons to incentivize homeowners to pump their septic system. These project activities supported a multifaceted education and outreach campaign on groundwater protection throughout Ravalli County. This project was funded by DEQ at $87,339.
- Between 2013 and 2017, the Clark Fork Coalition completed an irrigation infrastructure improvement project on Lost Horse Creek. Previously, an earthen dam across the creek was excavated yearly to maintain irrigation water conveyance—a practice that resulted in elevated turbidity and a fish passage barrier. CFC and partners replaced the gravel coffer dam with a siphon and developed an agreement with the Ward Irrigation District that ensured a minimum flow of 10 CFS is maintained for the life of the project in Lost Horse Creek. Project activities resulted in cooler water temperatures by increasing the flows in Lost Horse Creek. This project was funded by DEQ at $134,000, FWP at $102,850, DNRC at $100,000, USFWS at $60,000, and Columbia Basin Water Transactions program at $80,000.

SECTION 4: PROJECTS AT-A-GLANCE (EPA ELEMENTS #6 AND 7)

The following section summarizes BRWF's restoration projects in terms of timelines and relevant project statistics. As new projects develop, information will be added to these charts.

4.1 Implementation Schedule For BRWF's Past and Upcoming Projects

	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
EAST FORK: Highway 93 Roadside riparian planting (section 3.4)											
CAMERON CREEK: Private land Livestock fencing for improved grazing (section 3.5)											
DORAN CREEK: Private land Riparian planting and shading (section 3.4)											
BURNT FORK CREEK: Irrigation areas Inventorying and assessing irrigation diversions (section 3.10)											
CAMERON CREEK: Private land Riparian planting and shading (section 3.5)											
RYE CREEK and SLEEPING CHILD CREEK: USFS land Road decommissioning (section 3.6, 3.7)											
RYE CREEK: Private land Vegetation and bank stabilization (section 3.6)											
EAST FORK: Private land at Lazy J Cross Riparian planting and livestock fencing (section 3.4)											
MILLER CREEK: Oxbow Farm Riparian Planting and livestock fencing (section 3.12)											
BITTERROOT RIVER: Skalkaho Bend Public Park Bank stabilization and revegetation (section 3.2)											
BITTERROOT RIVER: Stevensville Fishing Access Site Riparian revegetation (section 3.2)											
BURNT FORK CREEK: Private land Riparian revegetation and livestock fencing (section 3.10)											
THREEMILE CREEK: Wilderness Management Area Fish passage (section 3.11)											
EAST FORK: USFS land Road decommissioning (section 3.4)											
EDUCATION AND OUTREACH Project tours, community presentations, school programs (section 6)											

LEGEND
Project preparation
Project implementation
Monitoring and maintenance

4.2 Projects At-A-Glance: Upcoming Measurable Milestones

Location	Restoration Strategy	Impairment or Beneficial Use Addressed	Schedule	Lead Partners	Approx. Cost	Project Statistics
Bitterroot River at Skalkaho Bend (Section 3.2)	Riparian revegetation and vegetation-based bank stabilization	Temperature, Aquatic Life	2019-2021	BRWF	$200,000	Revegetation on 1.8 acres, .3 stream miles improved, heavy public education activities
Bitterroot River at Stevensville FAS (Section 3.2)	Riparian revegetation	Temperature, Aquatic Life	2019-2020	BRWF, FWP	$49,500	Revegetation on .25 acres, heavy public education activities, .05 stream miles improved
Threemile WMA (Section 3.11)	Road upgrade; culvert replacement; fish passage	Sediment Aquatic Life	2019-2020	BRWF, FWP	$83,400	1 culvert upgraded, 1 bridge constructed, 1.7 miles road BMPs implemented, 2.5 miles Westslope Cutthroat habitat reconnected
North Burnt Fork Ranches (Section 3.10)	Riparian revegetation	Sediment Nutrients Aquatic Life Primary Contact Recreation	2019-2020	BRWF	$61,025	.6 miles riparian fencing installed, 4.7 acres revegetated, .3 stream miles improved
South Valley Floodplain Creation in Bitterroot National Forest (section 3.4)	Road restoration	Sediment, Temperature, Aquatic Life, Alteration in Streamside or Littoral Vegetative Cover	2020 onward	BNF, BRWF	$56,480	Miles of road decommissioned TBD

SECTION 5: IMPLEMENTATION ASSISTANCE (EPA ELEMENT #4)

5.1 Technical Assistance

While BRWF does not have staff scientists or an official technical advisory committee, we do have an active Projects Committee and a network of local partners who provide technical assistance and guidance as needed during project selection, development, implementation, and monitoring. We will continue to routinely request technical assistance from the appropriate federal and state agencies and regional scientists.

Field	**Name**	**Affiliation**	**Role**
Fisheries Biology	Jason Lindstrom, Chris Clancy	FWP	Project selection, development, implementation, and monitoring
Hydrology	Andy Efta, Marilyn Wildey, Ed Snook	BNF	Project selection and development
Natural Resource Conservation	Stacy Welling	NRCS	Project development
Natural Resource Conservation	Julie Ralston, Howard Eldredge, Kent Myers	BCD	Project development and implementation
Soil Science	Cole Mayn	BNF	Project selection and development
Water Quality	Hannah Riedl	DEQ	Project selection, development, implementation, and monitoring
Restoration Project Design	Marisa Sowles and Tom Parker	Geum Environmental Consulting	Education and outreach, project design and implementation
Irrigation	Al Pernichele	Bitterroot Water Commissioner	Project selection and development
Agriculture and Ranching	Patrick Mangan	MSU Extension	Project selection and design

5.2 Financial Assistance

Because each management measure or restoration project will generally call for a different funding approach, we expect to use a wide range of funding sources to implement this WRP. Table 6.2 includes a partial list of potential funding sources.

Funding Source	**Types of Projects Funded**	**Applicable BRWF Projects**	**Timeline**
MT DEQ Section 319 Grants	Addressing NPS pollution and meeting TMDLs	Bitterroot River at Skalkaho Bend Stevensville FAS Burnt Fork Private Lands Restoration	App due in Fall, funding available in August
MT Soil and Water Conservation Districts Mini Grants	Education and outreach	Small restoration efforts with educational component; Field trips	Spring
MT FWP Future Fisheries Improvement Program Grants	Benefiting fish	Threemile WMA Road Restoration	Dec 1, June 1
USFS Partnership Grant	Benefitting USFS resources		Ongoing
USFS RAC	Protecting/enhancing water resources; education, trails, and roads projects	Projects in partnership with BNF; road and culvert work with Ravalli County; projects on private land that have a public benefit	Annually
NFWF 5 Star and Urban Waters Restoration Program	Developing community capacity to sustain local natural resources for future generations		February
MT DNRC Watershed Planning Assistance Grants	Watershed planning for conservation districts	Developing projects that bring neighbors together to complete work within a subwatershed	February, August, November
MT DNRC Renewable Resource Grant and Loan Program	Development, management, conservation, and preservation of renewable resources	Irrigation infrastructure projects in partnership with irrigation districts and/or Conservation District, County, or City	May 15 2020, 2022
BoR Cooperative Watershed Management Program Grants	Project planning and development, research, implementation of restoration projects	Outyear project planning; project development; irrigation and infrastructure working group	Nov 15 2019, every two years
Friends of Lee Metcalf	Match for projects that improve habitat or water	Creekside Fencing on Burnt Fork Ranches	As requested

	quality in the vicinity of Lee Metcalf National Wildlife Refuge		
Bitterroot Audubon Society	Match for projects that improve avian habitats or populations	Riparian Revegetation at Skalkaho Bend Park	As requested
Volunteers	In-kind match towards project implementation, monitoring, and maintenance	Volunteers have been key contributors	As requested

SECTION 6: EDUCATION AND OUTREACH (EPA ELEMENT #5)

An informed and involved watershed community is imperative for the success of watershed restoration efforts. Projects and progress cannot be achieved without the support of local landowners; earning this trust depends on understanding and trust in the restoration organization. This notion extends beyond the owners of waterfront properties on which potential projects exist, and requires support from local community members via volunteerism and financial contributions. The BRWF focuses on educating youth, providing opportunities for young people to partake in educational activities and restoration projects as a way to engage and inspire future stewards of our water resources.

Tool	**Education or Outreach Activity**	**Timeline**	**Approximate Cost**	**Approximate number of People Reached**
Website + Social Media	Conveys watershed information to the public. Includes all watershed group information and current activities.	Ongoing	$400 per month	Ranging from 500-800 sessions quarterly
Newsletter	Sent to landowners and donors to inform them about current activities and proposed projects, and includes interesting news relevant to the restoration efforts.	Twice per year	$4/recipient	700 biannually
Watershed Trailer	Set up at community events to showcase projects	When opportunities arise	$1000 per showing	Varies greatly
Bitterroot Conservation District Updates	Updates on current projects; request future projects	Monthly	$200 per month	10 bimonthly
Tours	Showcase completed projects and highlight areas where work still needs to be done to improve the overall health of the watershed; to educate about water in the region	Annually	$1,500 per tour	20-50 people
Community Presentations	Draw attention to BRWF's efforts in the watershed; Showcase completed projects to the public	When opportuniti es arise	$150 per presentation	Varies from 20-200 people
Field Trips	Educate local students about water usage and management needs	One to two per year	$1,500 per trip	Varies from 30-200 students
Annual River Clean Up Event	Draw attention to BRWF's efforts in the watershed; community unification	Annually	$5,000 per year	Ranges from 125 - 200 community members

Earth Stewardship Program	Partner with several Bitterroot schools; connect students with natural resource professionals; encourage youth to explore local resource issues	Each school year	$7500 per year	Ranges from 150 - 225 students
Realtor Training	Partner with local Realtor Association to hold Continuing Education Credits focused on watershed and water issues	Annually	$1750 per class	Ranges from 50-150 Realtors

SECTION 7: MONITORING AND EVALUATION (EPA Element #8, #9)

Monitoring and evaluation plans will measure progress, assess maintenance needs, and track project successes and failures.

7.1 Monitoring

The following table lists the monitoring methods restoration actors in the Bitterroot Watershed have used in the past as well as methods that may expand monitoring capacities in the future. BRWF's Projects Committee develops project-specific monitoring plans and addresses data gaps in individual projects. Monitoring activities include both baseline monitoring to evaluate current conditions, and effectiveness monitoring to evaluate project impacts. All entities conducting monitoring should follow standardized protocols so that results can be compared and progress towards goals tracked over time. Monitoring plans, including coordinating with responsible entities, will be completed for each project during the planning phase. Adaptive management—being aware of changing conditions and addressing them as better information becomes available—will allow us to improve the process, prioritize projects, and revise the WRP over time.

Parameter	**Monitoring Method**	**Responsible Party Or Technical Lead**	**Primary Application**
Temperature	USGS Gaging Stations	USGS	Long-term trend monitoring
	Temperature Loggers	FWP, BNF, TU	Long-term trend monitoring and project effectiveness evaluations
	University of Montana graduate student temperature collection data	BRWF, students	Long-term trend Monitoring and project effective evaluations
	Riparian cover analysis (remote, using aerial imagery)	DEQ	Long-term trend monitoring
Streamside or Littoral Vegetative Cover	Photopoint monitoring[77]	BRWF, TU	Project effectiveness evaluations
	Plant community composition	BRWF	Project effectiveness evaluations
	Qualitative or semi-quantitative monitoring of weed species abundance and	USFS	Project effectiveness evaluations

[77] Representative photos will be used to show changes at a project site resulting from a specific habitat restoration activity, such as riparian planting and/or fencing. A combination of photos from different vantage points will be taken to highlight overall conditions. These photos will be updated periodically to demonstrate changes at the site and gauge the effectiveness of restoration methods overtime. Photos will also be used as needed to document events or incidents that may require action (e.g., damage to a site caused by high water events or fire) or to highlight a specific sample point within a project area.

Parameter	Monitoring Method	Responsible Party Or Technical Lead	Primary Application
	distribution		
	Greenline Assessments	DEQ	Project effectiveness evaluations and long-term trend monitoring
Sediment	PIBO[78]	USFS	Project effectiveness evaluations
	Pebble counts	DEQ, FWP, BNF	Project effectiveness evaluations
	WEPP: Roads Modeling[79]	BRWF	Project effectiveness evaluations
Metals	Water Quality Sampling	DEQ, MBMG	Project effectiveness evaluations and long-term trend monitoring
Nutrients	Water Quality Sampling	DEQ, TU, BRPA	Project effectiveness evaluations and long-term trend monitoring
	Macroinvertebrate assessments	FWP, BNF	Project effectiveness evaluations and long-term trend monitoring
Flow Regime	Gaging stations	USGS	Long-term trend monitoring
	Instantaneous discharge measurements	DNRC, DEQ, FWP, TU	Project effectiveness evaluations
	Groundwater-surface water interaction	Montana Bureau of Mines and Geology	Long-term trend monitoring

[78] PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO) Method: PIBO monitoring is an effectiveness monitoring program with varied types of monitoring, including vegetation analysis, aquatic invasive inventorying, and instream monitoring, to determine changing aquatic conditions.

[79] The Water Erosion Prediction Project (WEPP) model for roads is designed to predict runoff and sediment yield from roads, compacted landing and skid trails, and compacted foot, cattle, or off-road vehicle trails. WEPP: Road modeling allows the user to specify the characteristics of the road by climate, addition of soil or gravel, road design and surface condition, ditch condition, and local topography. Roads modeling is used to calculate erosion and deposition to estimate the annual amount of sediment leaving the road.

Parameter	Monitoring Method	Responsible Party Or Technical Lead	Primary Application
Physical Substrate Habitats	Sediment and habitat assessment	USFS, FWP, DEQ	Project effectiveness evaluations and long-term trend monitoring
	Fish population surveys	USFS, FWP	Project effectiveness evaluations and long-term trend monitoring
	BANCS model/BEHI method	DEQ	Project effectiveness evaluations
	WEPP: Roads Modeling	USDA	Project effectiveness evaluations
	Pebble counts	USFS, FWP	Project effectiveness evaluations
	USLE model	Undefined	Long-term trend monitoring
	Photopoint monitoring	USFS, FWP, BRWF	Project effectiveness evaluations
	Culvert and irrigation infrastructure aquatic organism passage surveys	USFS, FWP, TU	Project effectiveness evaluations and long-term trend monitoring
	PIBO	USFS	Project effectiveness evaluations
Aquatic Life	Fish population surveys	USFS, FWP	Project effectiveness evaluations and long-term trend monitoring
	Watercraft inspections	FWP	Long-term trend monitoring
	Aquatic plant and plankton sampling	FWP	Project effectiveness evaluations and long-term trend monitoring
	eDNA sampling or Polymerase Chain Reaction testing	FWP	Project effectiveness evaluations and long-term trend monitoring
	Fish pathogen testing	FWP	Project effectiveness evaluations and long-term trend monitoring

Parameter	Monitoring Method	Responsible Party Or Technical Lead	Primary Application
Education	Metrics tracking number of people reached at events, forums, presentations, etc.	BRWF	Project effectiveness evaluations
	Metrics tracking number of publications distributed	BRWF	Project effectiveness evaluations

7.2 Criteria for Determining Success

This WRP will be updated every five years. In 2025 and during subsequent revision cycles, WRP priorities will be reviewed. Project data will be compiled and evaluated against these criteria to determine the success of these strategies and identify where changes in objectives are required. Goals and progress are provided for BRWF endeavors only.

Objective	Criteria (Goal)	Progress 2014-2019
Increase local access to watershed education through outreach at events and retention of contact information	Increased number of people participating in events, school education programs, tours (50%) Increased number of people receiving newsletter and e-news (100%)	98% increase in participants 193% increase in recipients
Increase local participation and engagement in restoration activities	Increased number of participants in local restoration activities including revegetation projects, and River Clean Up (25%)	19% increase in project participants 34% increase in Clean Up participants
Trend of decreased stream temperature	Increased effective shade along priority streams (proxy for temperature) (1%)	Aggregate data not available[80]
Increased streamside vegetative cover	Native plants planted in riparian areas (15,000) Survival rate of native plantings (75%)	7,779 plants 70%
Reduced sediment loading to sediment impaired streams	Sediment load reduction estimates (300 tons /year) Miles of road improved (25 miles) Road crossings improved (50 crossings) Miles of streambanks improved (10 miles)	198.6 tons/year 20 miles 42 crossings 4.1 miles
Improved riparian habitat	Miles of riparian fencing installed (10 miles) Number of landowners participating in grazing management strategies (8 landowners)	4.8 miles 5 landowners

[80] See DEQ's *Water Quality Standards Attainment Records* and *Riparian Evaluation and Wetland Priorities Results* for stream-specific information.

APPENDIX A: O'BRIEN CREEK DATA

Reference Datum

To fundamentally assess O'Brien Creek, regionally based bankfull stream dimensions and local staff gage data provide important insight on basic healthy geomorphic and hydraulic functions for which stream surveys can be compared. Figure A.1 displays local relationships for stable channel conditions for a 25 sq. mi. Drainage area as well as discharge information at the current staff gage site at Blue Mountain road (USGS, 2004; Lolo National Forest, 1999; CFC, 2019). As displayed by bankfull discharge and measurements at the relatively stable staff gage site, O'Brien Creek fits local relationships; therefore measured stream dimensions and/or dimensionless ratios should be similar for stable conditions in equilibrium.

	Bankfull Channel With (ft.)	Mean Bankfull Channel Depth (ft.)	Mean Bankfull Cross-sectional Area (sq. ft)	Bankfull Discharge (CFS)
Western Montana (Mean annual basin precip. < 30 in.)	16.5	1.2	19.9	71.0
Lolo National Forest (mean annual basin precip. 21"-31")	No data	No data	No data	90
O'Brien Creek @ Blue Mtn. Rd staff gage	~12.5	~1.5	18.8	74.2

Figure A.1: Relationships for bankfull channel dimensions for a 25 sq. mile watershed. O'Brien Creek fits local relationships; therefore, stable stream dimensions should be similar.

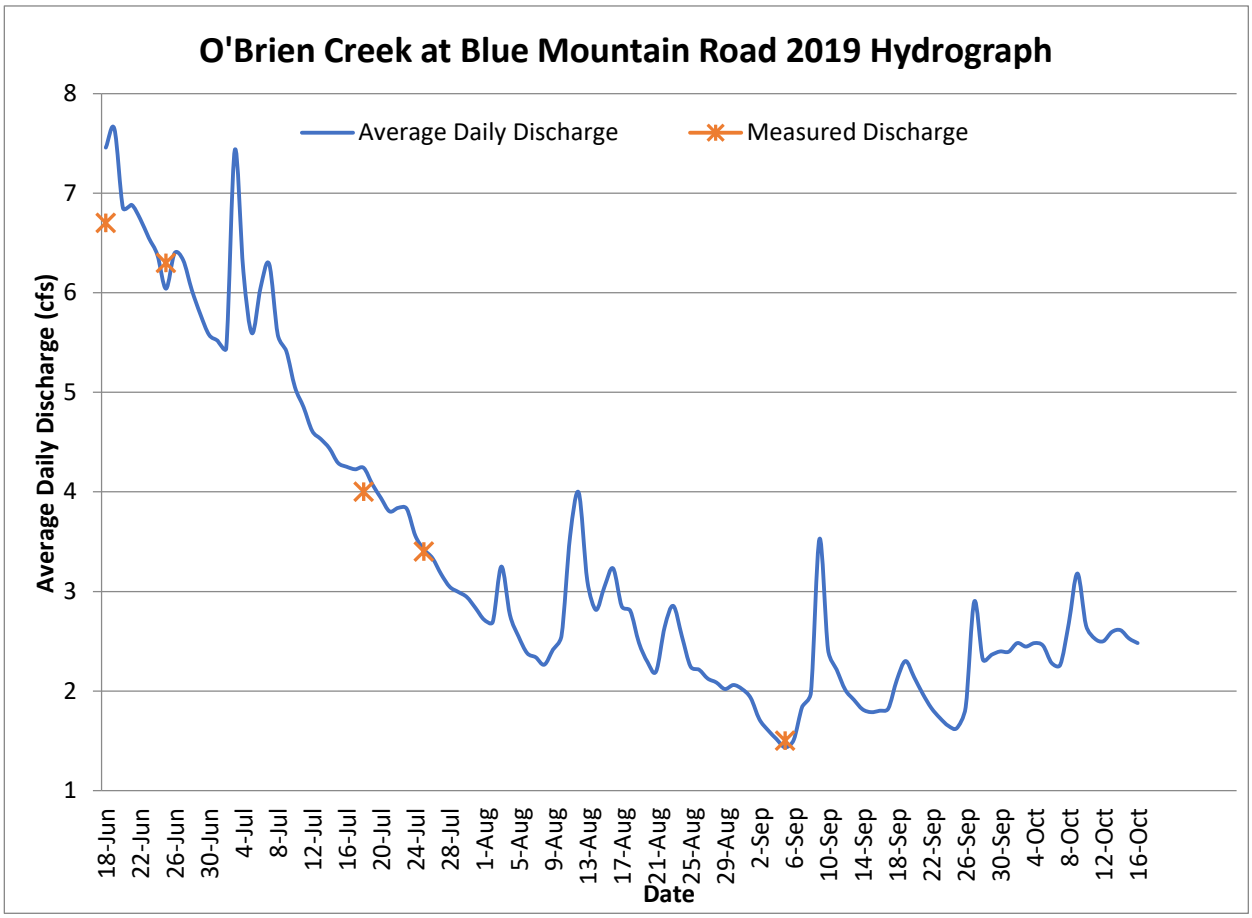


Figure A.2: 2019 June-October Stream Discharge; Staff gage at Blue Mtn. Rd.

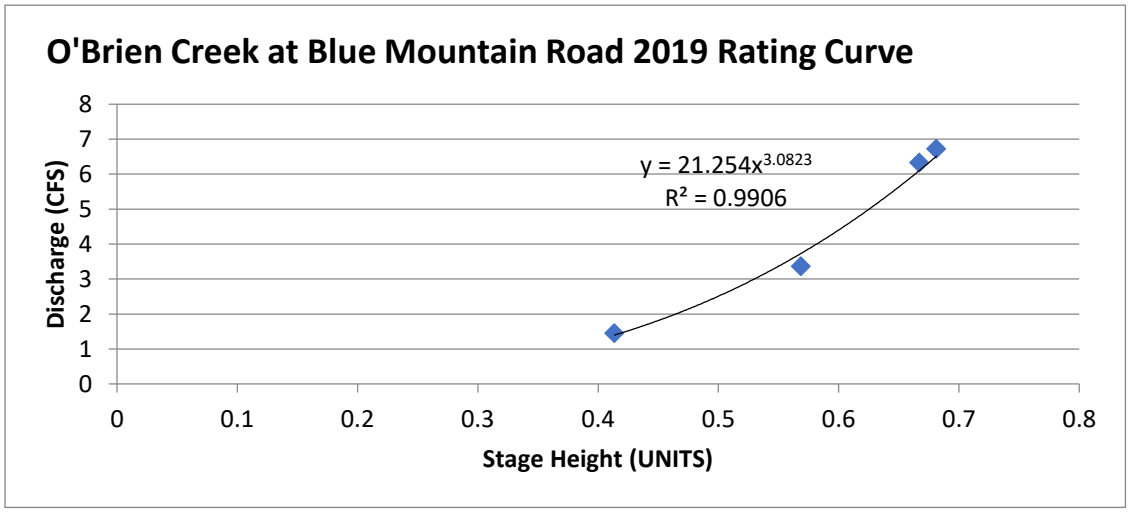


Figure A.3: 2019 Discharge-stage rating curve on O'Brien Creek at Blue Mtn Rd.

In 2019, a general inventory of stream conditions and surveys were conducted on landowner-supported-private, county, and USFS land throughout the watershed (USFS, 2019). Stream reaches on the mainstem were delineated into the nine sections identified in Figure A.4, below (segments are labeled 1-9 from east to west - downstream to upstream).

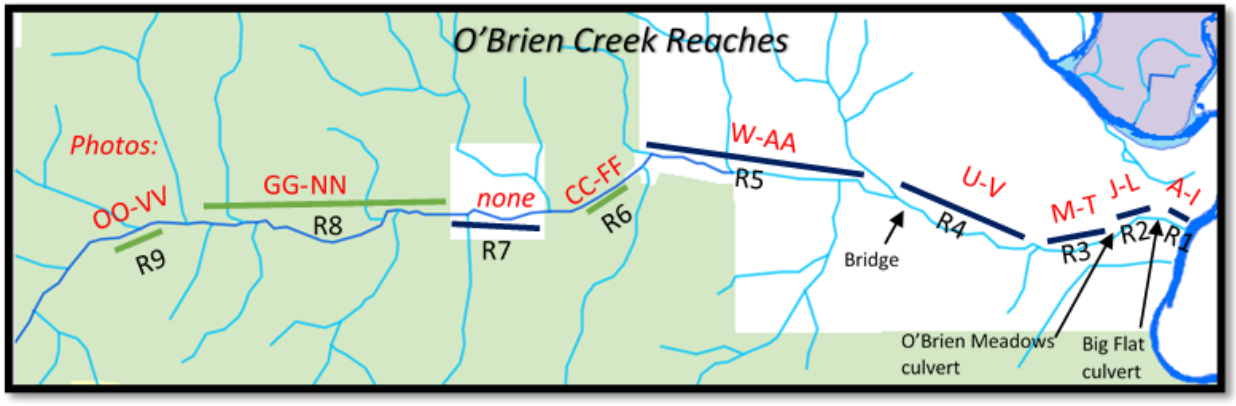


Figure A.4. O'Brien Creek Stream Reach Delineations – 2019 Stream Data (USFS, 2019)

Based on the 2019 surveys and as displayed in reach descriptions, Figure A.5 provides a ranking by reach for highest non-point source sediment delivery, including ranking of active downcutting segments. Figure A.6 provides a map of the Contributing Sediment Source Survey for non-point source sediment pollution.

Highest to Lowest Sediment Delivery Risk								
3	1	8	2	6	5	7	4	9
Highest to Lowest Incision Rates and Risk								
2	1	3	8	6	5	7	4	9

Figure A.5: Reach Ranking for Highest Sediment Delivery and Incision Rates (USFS, 2019)

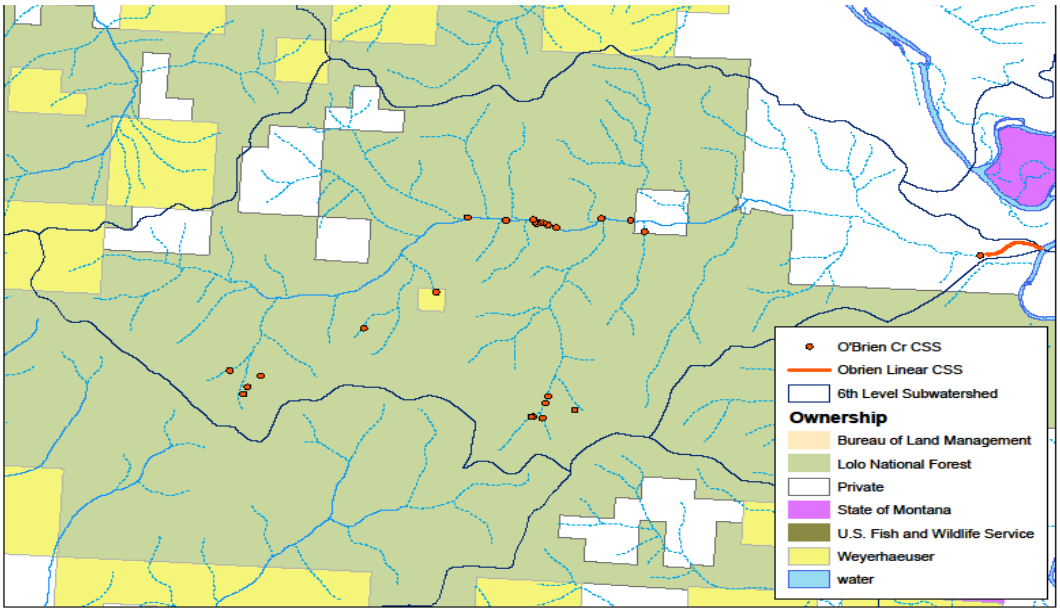


Figure A.6: Non-point source contribution sediment source map (USFS, 2019)

R***each 1 (R1) – Bitterroot Confluence to Blue Mountain Road***

Reach 1 is characterized by high to very high bank erosion (Bank Erodibility Hazard Index, BEHI, estimates, USFS, 2019) and is approximately 400-600 feet in length (Bitterroot Confluence to Blue Mountain crossing). Previous stream rehabilitation structures (early 2000s era) are present with many failed or failing. This reach has very little pool habitat and appears to be in rapid state of degradation, incision, and bank erosion. The active stream channel is entrenched (bank height ratios are approximately 3 times mean bankfull depth) and there is little to floodplain connection in the lower reach – the majority of flood flows are forced within the active channel causing very high near-bank stress during high flow events. As importantly, the land loss associated with stream bank failure is high within this stretch of private land.

Reach 1 is in immediate need of remediation and undoubtedly is contributing excessive sediment loads to the Lower Bitterroot River. Equally of focus is the lack of opportunity for cold-water fisheries refugia from warm summer Bitterroot stream temperatures that could be afforded by the relatively cold stream temperature of O'Brien Creek, if this section provided appropriate deep pool habitat, healthy streambanks, and dense streamside vegetation. With progressive rehabilitation design and implementation, this reach could substantively contribute to fisheries habitat within the reach and provide much improved connectivity for fish movement to the upper watershed.

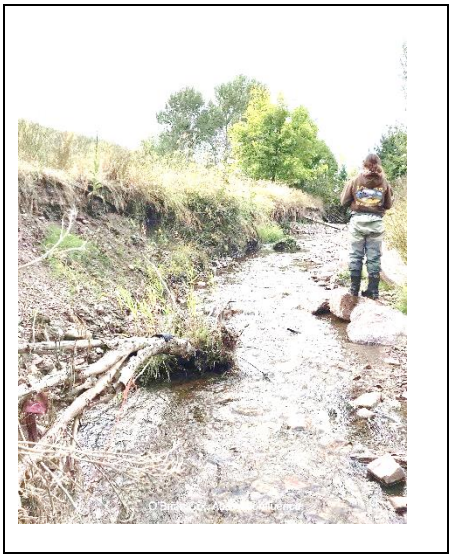


Figure A.7: Reach 1 – Typical stream condition in reach immediately upstream of Bitterroot River

Figure A.8 displays channel measurements with several that vary substantively from desired stable conditions (Avg. width is 13 ft. with variation of 7.1 feet between minimum and maximum; Cross-sectional area available for normal high runoff averages 21.7 sq. ft. and varies up to 43% (highlighted red text represent undesired deviation from stable conditions). Thirty-five pieces of LWD and one aggregate log jam was counted, indicating that previous rehabilitation activities utilized wood and/or the Blue Mountain road-stream crossing is facilitating wood transport.

Active Channel Width (ft)	Max Active Channel Depth (ft)	Approx. Cross-Sectional Area (sq. ft)	Est. Bank Height Ratio (Bank Ht/Channel Depth- photo scaled, no meas.)	Entrenchment Ratio (Floodprone Area Width/Channel Width)
13.1	1.9	24.9	~3	2.0
16.4	1.9	31.1	~3	2.3
10.2	1.3	13.2	~3	2.1
9.6	2.2	21.1	~2	>3.0
16.7	1.1	18.4	~2	3.1
Stable Regional Average 16.5	Stable Regional Average 1.2	Stable Regional Average 19.9	Rosgen B<1.5 typ. Rosgen C <1.5 typ. (Rosgen, 1999)	Rosgen B (1.4-2.2) Rosgen C (>2.2) (Rosgen, 1996)

Figure A.8: Reach 1 - Active channel measurements and comparison to stable channel averages

Reach 1 Summary: Significant departure from stable bankfull conditions (values in red, Figure A.8 above), high bank erosion and land loss, channel incision, active head-cutting, loss of floodplain connectivity, lack of dense riparian vegetation, lack of pool habitat.

Reach 2 (R2)– Blue Mountain Road to O'Brien Meadow Subdivision Crossing

Reach 2 consists of the segment between Blue Mountain Road and the road crossing accessing O'Brien Meadow Subdivision. The crossing at the lower end of the reach at Blue Mountain Road is a 20' wide concrete structure (Figure A.9). Stream substrates exist continuously throughout the structure, indicating that fish passage is likely possible at most flows. Additional morphologic assessment is necessary to determine an appropriate bankfull width; however, a reasonable estimate is 12-14 ft. As such, the road crossing span is likely meeting typical stream-simulation design criteria to accommodate at least the bankfull width. Flooding freeboard to accommodate large debris and bedload during large floods may be compromised. (Figure A.10).

Figure A.9. Road crossing of O'Brien Creek at Blue Mountain Road and bank failure immediately upstream.

Reach 2 is actively incising upstream of the Blue Mountain Road with significantly undersized channel capacity. Because of the low stream widths, stream depths are deeper and holding some fish.

Figure A.10. Road crossing to O'Brien Creek Meadow Subdivision and critically undersized and actively downcutting segment downstream of the subdivision crossing and upstream of Blue Mtn. Rd.

Stream dimensions were surveyed and displayed in Figure A.11. below. Dimensions are indicative of unstable stream conditions (red highlight), as indicated by variability and departure from regional stable averages.

Active Channel Width (ft)	Max Active Channel Depth (ft)	Approx. Cross-Sectional Area (sq. ft)	Est. Bank Height Ratio (Bank Ht/Channel Depth- photo scaled, no meas.)	Entrenchment Ratio (Floodprone Area Width/Channel Width)
13.6	1.4	19.0	~1	3.3

8.5	1.6	15.7	~2	1.8
7.5	1.5	13.2	~2	1.8
7.7	1.6	20.8	~2	2.7
Stable Regional Average 16.5	Stable Regional Average 1.2	Stable Regional Average 19.9	Rosgen B<1.5 typ. Rosgen C <1.5 typ. (Rosgen, 1999)	Rosgen B (1.4-2.2) Rosgen C (>2.2) (Rosgen, 1996)

Figure A.11: Reach 2 - Active channel measurements and comparison to stable channel averages.

Reach 2 Summary: Significant departure from stable bankfull conditions (values in red, Table X above), high bank erosion and land loss, channel incision, active head-cutting, loss of floodplain connectivity, lack of dense riparian vegetation, lack of pool habitat.

Reach 3 (R3) – O'Brien Meadow Subdivision Crossing to Next Upstream Road Crossing

This reach starts at the road crossing accessing O'Brien Creek Meadow Subdivision. The culvert here is a 9.6' round culvert. Stream substrates exist throughout the culvert and fish passage is likely achieved at most flows, but should be verified. Discharge from an irrigation ditch enters through a culvert immediately downstream of the crossing.

This reach is characterized by variability, substantive instability, and like Reach 1 and 2, recently accelerated downward trend in channel condition. Immediately upstream of the O'Brien Meadow crossing, one segment is critically undersized where cottonwood trees encroach the channel, leaving widths as narrow as 5-6 ft. with active incision. Within 200 ft. of the undersized channel segment, a massive bank failure site exits (Figure A.13). In 2019 alone, estimates of sediment loads were 12-15 dump truck loads, causing large-scale channel deposition and avulsion. Bank failure has occurred previous to 2019.

After the massive bank failure in 2019, the O'Brien Creek Meadow HOA was granted a two-phased 310 permit by Missoula Conservation District to conduct emergency actions to remove the substrate deposition without disturbing streambanks and returning wood to the channel (completed in 2019), then perform follow-up channel rehabilitation to restore adequately configured channel and floodplain dimension to reduce or eliminate the need for future maintenance. The second phase rehabilitation effort is awaiting funding for design and rehabilitation.

The upper segments of Reach 3 have 15-20 ft. channel widths. Head-cutting and incision is active in some segments, although others have floodplain connectivity. While the majority of this segment appears overly straight (needs assessment and verification), several high curvature bends exist. Another mass failure site and approximately 240 feet of bank erosion exists at the upper end of this reach. Old beaver chews were noted.

Active Channel Width (ft)	Max Active Channel Depth (ft)	Approx. Cross-Sectional Area (sq. ft)	Est. Bank Height Ratio (Bank Ht/Channel Depth- photo scaled, no meas.)	Entrenchment Ratio (Floodprone Area Width/Channel Width)
12.1	1.9	23.0	1-1.2	>8.3
14	1.2	16.8	1.2	2.8
6**	1.5**	9.0**	--	--
12	1.5	18.0	2	1.4 entrenched
11.9	1.7	20.2	2	1.1 entrenched
10.6	1.4	14.8	2	1.1 entrenched

Stable Regional Average 16.5	Stable Regional Average 1.2	Stable Regional Average 19.9	Rosgen B<1.5 typ. Rosgen C <1.5 typ. (Rosgen, 1999)	Rosgen B (1.4-2.2) Rosgen C (>2.2) (Rosgen, 1996)

*double line indicates boundary starting entrenched stretch

**Measured separately from reconnaissance survey. This is the critically constricted channel section approximately 200 ft. downstream of the massive bank failure site (photo below).

Figure A.12: Reach 3 - Active channel measurements and comparison to stable channel averages.

Figure A.13. Reach 3 - undersized segment, incision, bank erosion/land loss, and massive bank failure.

Reach 3 Summary: Significant departure from stable bankfull conditions. Massive bank failure, land loss, and sediment loading. 2019 Short-term remediated avulsion; channel incision, active head-cutting, loss of floodplain connectivity, instream wood loss, variable riparian vegetation density, lack of pool habitat.

Reach 4 (R4) – O'Brien Ck Road Crossing No. 3 to Road Crossing No. 4

Reach 4 is all private property along O'Brien Creek Road. Above the crossing at the upstream end, the stream transitions from the right to the left valley wall. From the road, the stream appears moderately entrenched with little instream wood or pool habitat. A lawn exists on both banks in one section with a footbridge. Before the road turns to gravel, no marked aggradation or erosion could be seen. More reconnaissance is needed to verify conditions.

Figure A.14: Reach 4 - Pasture and maintained lawn section.

Reach 4 Summary: Riparian vegetation, instream wood, and pool habitat appear lacking. Land loss and sediment delivery does not appear substantive, but assessment is needed to verify.

Reach 5 (R5) – O'Brien Creek Road Crossing No. 2 to Lower Forest Service Boundary

Reach 5 extends above private property along the gravel portion of O'Brien Creek Road until the first boundary with Forest Service land. At the downstream end, two culvert crossings can be observed from the road and appear undersized. About 400 ft. is located adjacent to the road fill. The stream is well shaded with some large instream wood and pools. Near the Forest Service boundary, the stream runs along the right valley wall in an old road bed. There is little to no riparian vegetation in one pasture segment and the left bank was eroding with slumping banks, land loss, and over-widened and shallow stream channel.

Figure A.15. Reach 5 – Private Land to Forest Service, public land boundary.

Reach 5 Summary: Lack of riparian vegetation in some segments with bank erosion and land loss present. One segment is substantively over-wide and shallow.

Reach 6 (R6) - USFS Section above Private Land

Reach 6 is an approximately 640 foot beginning just upstream of the boundary between private and USFS. Evidence of beaver was noted, but there were no dams. Approximately 75 feet of the left bank is adjacent to the road. The creek area near the trailhead is heavily used by recreationists with a user created trail and bridge over the creek. Pool habitat is limited. Erosive banks are prevalent with heights up to 4 t. At least

two road fill failures are causing substantive sediment delivery. This segment appears near an old road bed or historic railroad prism. Average stream gradient is 1.7%.



Figure A.16. Reach 6 – High bank erosion with some segments with low banks and floodplain connectivity.

Active Channel Width (ft)	Pool Depth (ft)	Approx. Cross-Sectional Area (sq. ft)	Bank Height Ratio (Bank Ht/Channel Depth- photo scaled, no meas.)	Entrenchment Ratio (Floodprone Area Width/Channel Width)
13.1	1.1	14.4	1.0	9 (not entrenched/ floodplain accessible)
Stable Regional Average 16.5	Stable Regional Average 1.2	Stable Regional Average 19.9	Rosgen B<1.5 typ. Rosgen C <1.5 typ. (Rosgen, 1999)	Rosgen B (1.4-2.2) Rosgen C (>2.2) (Rosgen, 1996)

Figure A.17: Reach 6 - Active channel measurements and comparison to stable channel averages.

Reach 6 Summary: Significant departure from stable bankfull conditions (values in red, Table X above), high bank erosion and land loss, channel incision, active head-cutting, loss of floodplain connectivity, lack of dense riparian vegetation, lack of pool habitat.

Reach 7 (R7) – Private In-Holding Reach

Reach 7 spans the length of the private inholding and was assessed from the road. The creek is braided with intermittency in some braids. The toe of the road fill is adjacent to the left streambank for substantive lengths with road fill failure and erosion. No pictures or measurements are available.

Reach 8 (R8) – Forest Service Boundary above Private In-Holding to End of Forest Road No. 123

Reach 8 starts from the second border with Forest Service property and continues past the gate to the end of Forest Service Road 123 (a non-motorized trail). Directly before the locked Forest Service gate on FS

Road No. 123, a large road failure is actively slumping into O'Brien Creek. As of early October 2019, the dimensions of the sediment contribution from the slump were measured to be 54 x 6 x 6.2 ft (approximately 2,678 ft^3). A newly fallen tree and road sign was in the stream. Parking is limited to one car, with 12 ft. road width and user-created turnaround off.

F*igure A.18: Reach 8 – significant bank erosion section along streamside Forest Road. No. 123.*

Above the upper Forest Service gate, Road No. 123, an old bridge crosses O'Brien Creek to decommissioned Road No. 19244. The bankfull width here is 10.2 feet. The bridge appears unsound with over widening at the inlet. Negative road and stream interactions continue upstream for several hundred feet with many road fill failures, bank erosion, and high sediment deliveries.

Figure A.19: Road 123 (non-motorized trail) – Reach 8 – High erosive banks caused from likely historic channel manipulation and recovering stream adjustments.

Reach 8 Summary: Significant departure from stable bankfull conditions, high bank erosion and land loss, channel incision, active head-cutting, loss of floodplain connectivity, lack of dense riparian vegetation, lack of pool habitat.

Reach 9 (R6) – End of Road Reach to Major Scree Slope on North Side of Valley

Reach 9 is a 600 ft. reach beginning at the end of Road No. 123 and ending just downstream of the major scree-slope and spring on the north valley wall. The stream goes dry for a section above this reach where the valley narrows. Erosive, high banks are typical of the reach. Some meander bends exist, resulting in deep pools. A short portion of the stream in this reach runs in an old road bed (perhaps old rail line). The slope of the entire reach was 2.7%.

This section is the first section of relatively good fish habitat formed by small diameter wood and many more pools than lower reaches. Large fish have been observed. Within approximately one mile upstream of the scree slope, previous stream reconnaissance discovered what appears to be the upper extent of historic channel manipulation evidenced by forested, canal-like structure adjacent to the stream.

More reconnaissance is needed, but it is currently thought that this section is the upper most historic channel disturbance with all channel stability beginning at the old canal-like structure and extending to the confluence with the Bitterroot River. Channel aggradation also occurs in this reach with high sediment sources originating from bank erosion.

Active Channel Width (ft)	Pool Depth (ft)	Approx. Cross-Sectional Area (sq. ft)	Bank Height Ratio (Bank Ht/Channel Depth- photo scaled, no meas.)	Entrenchment Ratio (Floodprone Area Width/Channel Width)
14.8	1.2	17.8	~2	No meas.
Stable Regional Average 16.5	Stable Regional Average 1.2	Stable Regional Average 19.9	Rosgen B<1.5 typ. Rosgen C <1.5 typ. (Rosgen, 1999)	Rosgen B (1.4-2.2) Rosgen C (>2.2) (Rosgen, 1996)

Figure A.20: Reach 9 - Active channel measurements and comparison to stable channel averages.

Figure A.21: Reach 9 – Bank erosion and aggradation present. Pool habitat and stream dimensions are more representative of stable channel conditions.

Reach 9 Summary: Erosive, high banks are typical of the reach. Some meander bends exist, resulting in deep pools and larger fish observed. 1-2 miles above this reach there is a historic canal-like structure that is thought to be the upper extent of historic channel manipulation. More reconnaissance is necessary.

Upper Watershed Sediment Delivery from Roads

Figure A.6 in first section displays contributing sediment sources located during WAM road surveys (USFS, 2019). Figure A.22 below displays erosion at stream crossing on old jammer roads. Most jammer roads are reforested, but some may need remediation to address sediment deliveries. Open roads are in need of maintenance and improvements to adhere to federal and state standards for best management practices.

Figure A.22: Failed log culvert on jammer road in Upper O'Brien Creek jammer road system.

Project Information

2019 Post-flood remediation at O'Brien Creek Road crossing included removal of substrate deposition, returning stream to existing channel, re-grading channel, and placing large trees at the base of the mass failure side to temporarily reduce undercutting and risk of more failure until appropriate channel design and rehabilitation can occur. There was fish salvage of a large rainbow trout trapped in the meadow grass during the avulsion. The O'Brien Creek HOA hired a specialized articulating excavator with clam-shell to carefully extract stream bed deposition with minimal channel disturbance per 310 permit requirements.


CAT

Figure A.23. Reach 3 - 2019 Emergency Channel Remediation conducted by O'Brien Creek HOA with tree donation from Hillsdale Estates. Mass failure and temporary remediation with large tree toe protection; salvage of large rainbow trout and macroinvertebrates.

Appendix A References

1. Crawford, C. Personnel communication. O'Brien Creek para-historian research in preparation for publication. Missoula, MT.
2. MT FWP. *Personnel communication with Ladd Knotek on O'Brien Creek importance to fishery*. Montana Fish, Wildlife, and Parks, Region 2, Missoula, MT [2019]
3. O'Brien Creek Meadow HOA. *Personal communication and stream remediation photos.* O'Brien Creek Meadow Subdivision, Missoula, MT. [2019]
4. Rosgen, D. *Applied Fluvial Geomorphology*. Wildland Hydrology. Pagosa Springs, CO. [1996]
5. USFS. *Unpublished bankfull discharge curves*. Lolo National Forest, Missoula, MT. [1999]
6. USFS. *Unpublished O'Brien Creek Reconnaissance and Stream Survey*. Missoula Ranger District, Lolo National Forest, Missoula, MT. [2019]
7. USFS WAM. Wildfire Adapted Missoula, Planning and Public Engagement. Missoula Ranger District, Lolo National Forest, Missoula, MT. [2019]
8. USGS. *Determination of Channel-Morphology Characteristics, Bankfull Discharge, and Various Design-Peak Discharges of Western Montana.* Scientific Investigations Report 2004-5263 [2004]

APPENDIX B: GLOSSARY OF TERMS AND ABBREVIATIONS

Alluvial: relating to, composed of or found in alluvium.

Alluvium: clay, silt, sand, or gravel deposited by running water

Anthropogenic: caused or produced by humans

Belt Series: major division of late Precambrian rocks in North America

BoR: Bureau of Reclamation

BMP: "Best Management Practices" are measures taken to reduce water pollution. For example, installing a silt fence during construction is a BMP to reduce sediment transported to a water body (river, lake, stream, ocean).

BNF: Bitterroot National Forest

BRWF: Bitter Root Water Forum

Confluence: The meeting of two or more bodies of water.

CFC: Clark Fork Coalition, a nonprofit that works to protect and restore water quality throughout the Clark Fork River basin.

DEQ: the "Montana Department of Environmental Quality" is a government agency in the executive branch state of Montana with a mission to protect, sustain, and improve a clean and healthful environment to benefit present and future generations.

DNRC: The "Montana Department of Natural Resources and Conservation" provides leadership in the management of state's natural resources and promotes stewardship of Montana's water, soil, forest, and rangeland resources.

EPA: The "United States Environmental Protection Agency" is an agency of the U.S. government created for the purpose of protecting human health and the environment.

FWP: Montana "Fish, Wildlife & Parks" is a government agency in the wildlife, and state-owned park resources in Montana for the purpose of providing recreational activities.

Glaciated: an area that is or has been covered in glaciers or ice sheets.

HOA: Homeowners Association

Load reductions: A decrease in the amount of pollution released.

Metamorphosis: rocks formed by heat and pressure causing physical or chemical change.

Metasedimentary: sedimentary rock altered by metamorphosis.

Nitrogen: is a common chemical element required by living organisms. Too much nitrogen in streams can cause excessive algal growth.

Nonpoint Source Pollution (NPS): pollution from diffuse sources, as opposed to "Point Source Pollution" that comes from a single, identifiable source.

Nutrient: A nutrient is a substance that an organism needs to live and grow. Common nutrients considered in stream ecosystems include nitrogen, phosphorous, and carbon.

NRCS: the "Natural Resource Conservation Service" formerly known as the Soil Conservation Service (SCS), is an agency of the United States Department of Agriculture (USDA) that provides technical assistance to farmers and other private landowners and managers.

Phosphorous: is a common chemical element required by living organisms. Too much phosphorous in streams can cause excessive algal growth.

RAC: a "Resource Advisory Committee" is a committee developed as part of the Secure Rural Schools Act, which decides on local community collaboration with federal land managers in recommending Title II projects on federal lands or that will benefit resources on federal lands.

Restoration: the return of a landscape, ecosystem, or other ecological entity to a predefined historical state.

Riparian: is the interface between land and a river or stream.

Sediment loading: sediment transported by a water body.

Silviculture: the growing and cultivation of trees

TMDL: A "Total Maximum Daily Load" is a regulatory term in the U.S. Clean Water Act, describing the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

TU: Trout Unlimited, a nonprofit that works to protect critical habitat, to reconnect degraded waterways, and restore populations to coldwater fisheries.

Subbasin Plan: Bitterroot Subbasin Plan for Fish and Wildlife Conservation, a basin-wide plan identifying biological objectives and strategies to protect, mitigate, and enhance fish and wildlife populations within the Bitterroot watershed.

Substrate: Earthly material that exists on the bottom of a riverbed, often dirt, rocks, sand, or gravel.

Tributaries: a stream or river that flows into a larger water body (river, lake, stream, ocean).

USGS: The "United States Geological Survey" is a scientific agency of the United States government. The scientists of the USGS study the landscape of the United States, its natural resources, and the natural hazards that threaten it.

Watershed: All of the land which drains precipitation in the form of rain or snow to a specific point.

Wetlands: A wetland is an area of the landscape that is inundated or saturated by surface or groundwater and supports vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

Project 3

2022 319 Application Form - Supplemental Project Form

**********REVISED 10/22/2021**********

Project Name	Miller and O'Brien Creeks Sediment Reduction and Restoration

A separate Project Form ***(including providing separate attachments)*** must be submitted for each project included in your application. Use the following examples to help determine when to lump and when to split projects. For additional assistance, contact Mark Ockey at mockey@mt.gov or 406-465-0039.

Splitting Examples (fill out multiple Project Forms)

- Stream restoration work occurring on two separate streams, on parcels owned by two separate individuals
- Two projects with significantly different sets of project partners
- Two projects that address substantially different pollution sources (e.g., one project moves a corral off of a streambank, and another removes mine tailings, with both projects being on the same property)

Lumping Examples

- Contiguous stream restoration work spanning multiple land parcels
- 3 projects that address similar sources of pollution on a single land parcel (e.g., moving a corral off a stream, implementing a grazing management plan, and relocating a manure storage facility out of the floodplain, all on the same ranch)

Project Name	Miller Creek Mile 7 Restoration

Select the watershed restoration plan (WRP) that your project will help implement.

Miller Creek - Missoula Valley Water Quality Protection District

Y — Letter of support from author entity attached? *(If no, explain why below.)*

Waterbody name from 2020 List of Impaired Waters	Miller Creek
Probable causes of impairment to be addressed	Sediment and Temperature
Waterbody name from 2020 List of Impaired Waters	
Probable causes of impairment to be addressed	

OR*

Name of healthy waterbody to be protected	
Description of identified threat to non-impairment status	
Name of healthy waterbody to be protected	
Description of identified threat to non-impairment status	

**While the majority of the available 319 project funding is dedicated to addressing known impairments, EPA is allowing states to use a limited amount of funding to protect non-impaired waters (healthy waters) from becoming impaired.*

Project Location

Upstream End	Latitude	46.776445	Longitude	-113.956920
Downstream End	Latitude	46.777425	Longitude	-113.961966
Centerpoint	Latitude	46.776739	Longitude	-113.958764

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

Upstream End	Latitude		Longitude	
Downstream End	Latitude		Longitude	
Centerpoint	Latitude		Longitude	

List the 12-digit Hydrologic Unit Code(s) (HUCs) in which the project area is located: 170102051601

☑ Project site map(s) attached, showing the location of all proposed on-the-grount restoration activities?

Community Participation and Support

Landowner	Contributions to Project	Letter of Support Attached?
Thomas and Donna Leik	Landowners	☑
		☐
		☐
		☐

Partner	Role	Letter of Support Attached?
Montana Fish Wildlife and Parks	Supportive of project, monitors the fishery, and assistance with designing and permitting the project. FWP biologist are no longer allowed to author letters of support.	☐
Missoula Valley Water Quality District	Supportive of project, monitors water quality on Miller Creek	☑
Westslope Chapter TU	Supportive of project, funder	☑
		☐

Other Community/Stakeholder Support

Project Description

Describe the nature and extent of the nonpoint source problem you are trying to address, the root causes of the problem, and your proposed solution.

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 previous and ongoing work in adjacent stream reaches. DEQ contributed funds to three similar projects on the mainstem Miller Creek in 2019 and 2020, one of which is directly upstream from the currently proposed project.

Miller Creek is listed as impaired for sediment and temperature. A Watershed Restoration Plan, written by the Missoula Valley Water Quality District, and a Habitat Assessment, written by the Clark Fork Coalition, were completed in 2018. Both found impacts from sediment throughout the watershed, primarily due to channel incisement. Flow and temperature monitoring in 2018 corroborated past findings of high water temperatures and de-watering in the lower to mid reaches. The high levels of sediment are affecting landowners' infrastructure by constricting road culverts, filling irrigation diversions, and adding to channel instability. Additionally, the high sediment load, high water temperatures and dewatering are negatively affecting the fishery, translating to lost angling opportunities on Miller Creek and the Bitterroot River. Miller Creek is a historically productive fishery and an important tributary for spawning Westslope cutthroat and rainbow trout in the lower Bitterroot River and contains pure strain Westslope cutthroat trout in at least two of its tributaries.

The source of much of the sediment is active erosion of streambanks along the entirety of the creek. For this proposal, the Clark Fork Coalition would directly address this issue on approximately 1500 feet of Thomas and Donna Leik's property, immediately downstream of the 2021 Wustner project. Issues on this proposed reach includes vertically eroding banks, loss of connectivity between the channel and floodplain, increased fine sediment delivery to the channel, reduced habitat diversity, and reduced riparian vegetation and cover - all of which contribute to overall degraded conditions in the middle reaches of Miller Creek. The landowners board and own several horses, and while they are committed to limiting livestock access to the creek, their water gap is currently another source of sediment to the creek and could use improvements.

In order to address the sedimentation issues and increase habitat on this section of creek, the Clark Fork Coalition would employ a variety of restoration techniques that act as a continuation of the upstream project. Treatments such as floodplain grading, woody debris matrix, riparian shrub plantings with exclosure fences, a hardened crossing for horses, and other treatments to re-connect the creek to its floodplain, slow and disperse high flows, and increase riparian habitat will be used. Through the lessons learned on the 3 similar upstream projects, CFC has zeroed in on what treatments are most effective for treating each restoration issue on Miller Creek.

Is this project a continuation of a previous project? If so, please explain the connection.

Yes, this is a downstream continuation of the Miller Creek- Wustner 319 project that was completed in October 2021. This project continues the Wustner project an additional 1500 feet immediately downstream. Additionally, it continues the sediment and temperature treatments that occurred on the mainstem of Miller Creek on Spooner Creek Ranch a few miles upstream in 2019. DEQ has also contributed funds to a similar project on Miller Creek as it flows through the MPG Ranch property. This project is currently being designed and we anticipate a Fall 2022 implementation date.

Water Quality Benefits and Sustainability

Explain why the project is an appropriate next step for making progress towards removing a pollutant/waterbody combination from Montana's 2018 Impaired Waters List or preventing a healthy waterbody from becoming impaired?

The Miller Creek Watershed Restoration Plan identifies temperature and sediment to be the main sources of pollution to Miller Creek. The WRP suggests that the primary source of sediment to Miller Creek is eroding banks and channel encisement. The WRP reccomends addressing sediment by improving channel structure, allowing the creek to access its floodplain, and improving riparian vegetation. The project we are proposing will treat and stabilize vertically eroding banks, improve floodplain access, and increase riparian health. This project builds on the 3 previous 319 funded sediment reduction projects on Miller Creek and will directly address the sediment issues on Miller Creek.
Additionally, it is CFC's goal to restore the main channel of Miller Creek from river mile 7 to river mile 14 and to address fish passage issues in the basin. In addition we are working with the Oxbow Cattle Company and NRCS to restore the lowest 2 miles of Miller Creek and covert 8cfs of the most senior surface water rights to instream flow.

Will your project address a major local source of nonpoint source pollution? Explain.

Yes. As mentioned above, the WRP suggests that eroding banks are the primary source of sediment to Miller Creek. After completing a Miller Creek Habitat Assessment in 2018, CFC has a good understanding of where these sediment sources are located, and we are priortizing sections of the creek that contain them in the middle and upper reaches.

The proposed project site is characterized by 4-5 foot eroding banks, minimal riparian vegetation, and an inability for the creek to access its floodplain. We believe that by stabilzing the banks, improving floodplain access, and increasing riparian vegetation, sediment loading from these banks will significantly decrease after the project.

Will the project create long-term, sustainable reductions in NPS pollution? Explain.

Our proposed project will help return the creek to a more natural state by re-connecting the floodplain in entrenched segments, increasing riparian vegetation and woody debris, and stabilizing eroding banks in this reach. In both the short and long term, these actions should decrease sedimentation to the creek as banks are stabilized, floodplains are flooded, and riparian vegetation gets established.

This project will also prevent future degradation to the creek by implementing a 319-approved grazing management plan with the landowners.

Describe how the project will promote self-maintaining, natural, ecological and social processes that protect water quality?

By reducing streambank erosion and allowing the creek to access it's floodplain, we are restoring Miller Creek to a naturally functioning system that will reduce the amount of sediment entering the stream channel.

By reducing impacts from livestock with riparian fencing and hardened crossing, we expect this project will help equip the landowners with tools to continue protecting Miller Creek. The landowners are excited to be part of the transformation of Miller Creek on their property.

Nonpoint Source Goals and Success Metrics

Nonpoint source pollution goal	Action that will be taken to reach the goal	Metrics used to measure success
Reduce sediment loading to Miller Creek	Stabilize eroding banks, improve connection to the floodplain, improve riparian and instream habitat conditions, install hardened crossing for livestock	-Tons of sediment load reduction by measuring pre and post BEHI and Near Bank Stress -Riparian planting success monitoring -Photo points to show how the treatments are functioning over time

Project Education and Outreach

Describe the educational benefits of your project. Will the project inspire additional nonpoint source pollution prevention work within the watershed?

CFC has successfully engaged 5 landowners in active restoration projects on the mainstem of Miller Creek since 2019. Each landowner we have worked with has seen the work on their neighbors' properties and has approached us with questions on how to implement a project on their property. We feel that these projects continue to serve as an incredible showcase of what is possible when landowners, nonprofits, and agencies work together to find solutions that benefit all. We hope that this project will continue to inspire neighbors to ask questions and become engaged in the restoration of their backyard creek.

Bigger Picture Benefits

NPS pollution projects often have benefits that go beyond simply cleaning up Montana's lakes and streams. Describe your project's benefits to each of the items below. If there are no associated benefits, type "NA" for "not applicable".

Environmental Justice (EJ)

Will the project improve or create public access to a healthy environment?

Miller Creek flows into the Bitterroot River. By reducing the source of sediment to the creek and improving stream conditions, this project, coupled with past and future projects, could provide improvements to the overall health of both the Bitterroot and Miller Creek fishery, stream conditions, and water quality. Additionally, this project is located less than a mile from public access to Miller Creek through a creek-side trail on DNRC land.

Will the project have a public benefit in a county where 15% or more of the population lives below the poverty level? Counties include: Big Horn, Blaine, Chouteau, Deer Lodge, Garfield, Glacier, Golden Valley, Hill, Lake, Liberty, Lincoln, Meagher, Mineral, Musselshell, Pondera, Powell, Roosevelt, Rosebud, Sanders, Silver Bow, Toole and Wheatland.

N/A (project is located in Missoula County)

Will the project benefit historically underserved populations (e.g. minority populations, people with disabilities)?

This project is located less than a mile downstream from a ADA compliant creek-side trail with accessible fishing opportunites. This project could help increase fish numbers on the creek, potentially increasing angling opportunites from the ADA accessible trail.

Climate Change

Will the project improve climate change resilience for communities, native plants, wildlife or ecosystems?

Yes, by allowing the creek to access its floodplain, adding woody debris, and enhancing riparian vegetation, there is opportunity for increased groundwater and surface water storage, which is important as Montana's summers get hotter and drier. The enhanced riparian vegetation will also act as shade to prevent water temperatures from increasing during drought and low-water years. Stream runoff is predicted to become flashier and more extreme - our proposal affords greater channel resiliency towards fluctuations in both flooding and drought conditions.

Will the project restore or protect cool, late-season flow?

Yes, the project will lead to more connectivity to the floodplain. This could improve groundwater recharge and contribute to late season flows, both of which are chronic issues on Miller Creek.

Impacts to Downstream Communities

Will the project reduce pollutant loading above a permitted point source discharge in a way that could increase assimilative capacity in the the receiving water?

There is no known permitted point source downstream of this project site.

Will the project help protect a drinking water source?

This project does not involve drinking water.

Tasks and Budget

DEQ uses a standard template to develop scopes of work for 319 contracts. The tasks below match up with DEQ standard scope of work template. Some tasks might not be applicable to your project. Please leave the non-applicable tasks blank. If your project doesn't fit the task outline, use the task labeled "Other" to describe your project.

Task 1 - Project Planning Deliverables *(Include such things as completing project designs, conducting site evaluations, obtaining permits, organizing volunteers, conducting scoping meetings, etc. Identify specific deliverables that will be submitted.)*

Contractor shall submit to DEQ the following deliverables:
- A complete, draft copy of project designs for review and comment.
- A complete, final copy of project designs. In the final designs, Contractor shall address all concerns raised by DEQ in the review of previous drafts.
- A complete, detailed cost estimate for implementation of the final designs, and a list of potential funding sources for implementation.
- Copies of all permits necessary for implementation of the project designs.
- Documentation of the landowner's acceptance and approval of the final designs.

State Cash Match	Local Cash Match	In-Kind Match
$ 12,000		

319 Funding Request		Federal Match	Other Funding*	Total Planning Cost
$ 18,000	$ 12,000			$ 30,000
	Total Non-Federal Match			

Match Source	Future Fisheries	Secured	
Match Source	DNRC	Secured	
Match Source		Secured	
Match Source		Secured	

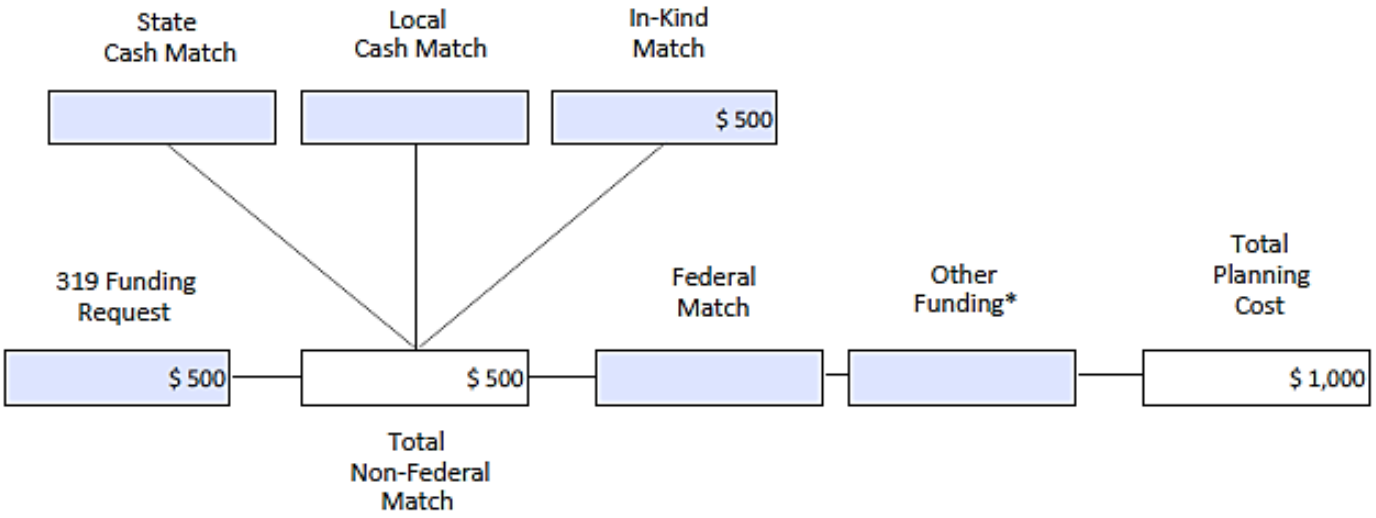
**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Landowner Agreements, Operation and Maintenance

This task only applies to projects involving on-the-ground activities. DEQ periodically evaluates the effectiveness of each on-the-ground project. To accomplish this, DEQ requires a process be in place to allow periodic access to the project site. The landowner agreement should also specify the roles of each project partner in the design, implementation and continued operation of on-the-ground pollution prevention practices. DEQ does not require the use of a specific landowner agreement template. In some situations, existing agreements between the project sponsor and the landowner may be sufficient.

Task 2 - Landowner Agreements, Operation and Maintenance Deliverables *(Include such things as landowner/ sponsor communication, and draft and final agreements.*

Contractor will submit to DEQ the following deliverables:
- Draft landowner agreements for review and comment, in Microsoft Word or pdf format. Contractor will submit all draft landowner agreements prior to signature, and allow sufficient time for review, comment, and subsequent modification prior to implementation.
-Draft grazing management plan for review and comment. Contractor will submit all draft plans prior to signature, and allow sufficient time for review, comment, and subsequent modification prior to implementation.
- PDF copies of signed landowner agreements. Contractor will ensure signed landowner agreements address all comments and concerns raised by DEQ.
-PDF copies of signed grazing management plan. Contractor will ensure signed grazing management plan will address all comments and concerns raised by DEQ



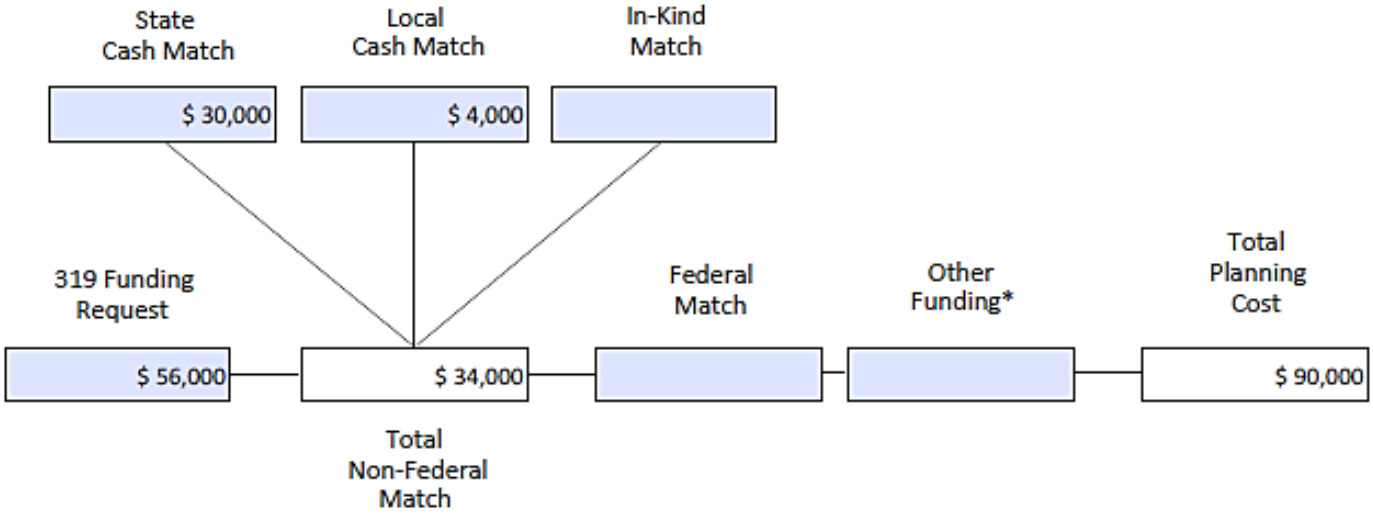
Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Implementation

Task 3 - Project Implementation Deliverables *(Include such things as construction oversight, implementation of on-the-ground restoration practices, preparation and submittal of as-built drawings, etc.)*

- Draft request for proposals (RFP) for DEQ review and comment (for implementation). Contractor shall submit draft RFP prior to release and allow at least 30 days for DEQ review, comment, and subsequent modification prior to release
- A final copy of the RFP
- Implementation of on-the-ground restoration
- A detailed description of any deviations from the final project map completed under project implementation task and an explanation for the need for each deviation.



Match Source	Future Fisheries	Secured	
Match Source	DNRC	Secured	
Match Source	WSCTU	Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Other Activities

Use this task if the activities you are proposing are outside the scope of the typical design/implement/monitor process. Provide sufficient details to enable application reviewers to successfully compare the nonpoint source pollution reduction benefits of your project to those of other projects in the applicant pool.

Task 4 - Project Deliverables *(Include activities you will complete and the products you will submit to demonstrate completion.)*

State Cash Match	Local Cash Match	In-Kind Match	319 Funding Request		Federal Match	Other Funding*	Total Planning Cost
				$ 0			$ 0

Total Non-Federal Match

Match Source		Secured	
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Project Effectiveness Monitoring

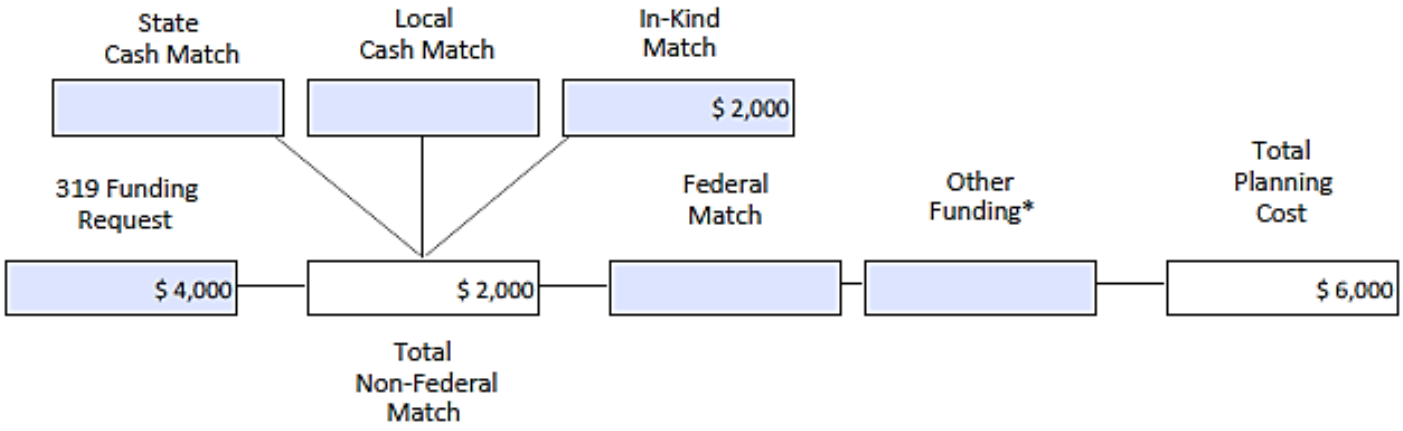
The short duration (1-3 years) and limited spatial extent (often just a few hundred yards) of most 319-funded projects frequently precludes the use of traditional water chemistry monitoring as a means of evaluating project effectiveness. Instead, DEQ encourages project sponsors to use simpler, more qualitative tools. Typically, this will include pre- and post-construction photo point monitoring, vegetation mortality measurements, and perhaps modeling to estimate pollution load reductions. Please contact one of the DEQ Nonpoint Source Program staff for guidance relative to your specific project.

Task 5 - Project Effectiveness Monitoring Deliverables *(Identify the specific tools and products you will use to evaluate and demonstrate the effectiveness of your project in reducing nonpoint source pollution.)*

Contractor shall submit to DEQ the following deliverables:
- A complete draft monitoring plan for review and comment in electronic (Microsoft Word) format, allowing sufficient time for review, comment, and subsequent modification prior to implementation. The monitoring plan must identify the specific monitoring that will occur, who will complete the monitoring, and how the data will be analyzed and reported.

- A final monitoring plan. Contractor shall ensure that the final monitoring plan addresses all comments and concerns raised by DEQ.

- A written summary of all monitoring activities. The written summary must include the following:
-Electronic copies of photo-point photographs, in JPEG format. A photo log identifying photo ID, site ID, photo date, photographer name, latitude and longitude from which the photo was taken, approximate direction the photographer was facing, and a brief description of what the photo is intended to show.
- Electronic copies of all data and data analyses.
- A detailed description of any deviations from the final monitoring plan, and an explanation of the need for each deviation.
- An estimate of sediment load reductions, in tons/year, achieved through implementing on-the-ground projects.



Match Source	CFC	Secured	✓
Match Source		Secured	
Match Source		Secured	
Match Source		Secured	

**Use this space to record any funding that will be used to support creation of the task deliverables, but will not be reported as match. The purpose of this information is to give application reviewers a clearer understanding of the total amount of funding required to complete a task.*

Additional Attachments

Attach additional items that could help reviewers better understand your project. Items could include site photos, design drawings, site evaluations, permits, etc. Please be conscious of reviewers' time, as they may not have time to read lengthy studies and reports. List all additional attachments below.

- [x] Pre-project photos
- [x] Miller Creek Watershed Restoration Plan
- [ ]
- [ ]
- [ ]
- [ ]

Additional information that could assist reviewers in evaluating the project's potential impact on NPS pollution.

Letters Of Support

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

Project Map

Mile 7 Miller Creek Proposed Restoration Project

Landowner: Thomas and Donna Leik
Polluted Waterbody: Miller Creek

GRAHAM RODNEY E

LEIK THOMAS H & DONNA A

WUSTNER JACOB C

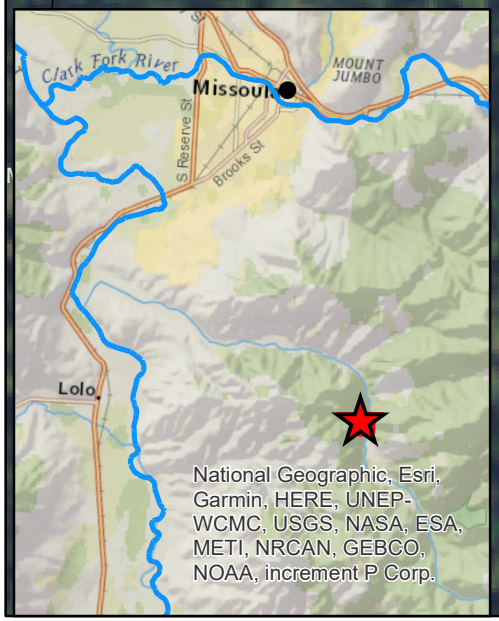
Bottom of reach
Lat/Long: 46.777425, -113.961966

Miller Creek

Top of reach
Lat/Long: 46.776455, -113.956950

LEIK THOMAS H & DONNA A

WUSTNER JACOB C



N

0 400 Feet

CLARK FORK COALITION

Supplemental Information

Photos of Sediment Sources on Leik Property October 2021

Miller Creek
Watershed Restoration Plan
2018

Missoula Valley Water Quality District

January 29, 2018

Acknowledgements

Many individuals and organizations helped support and guide the development of this Watershed Restoration Plan. The Soil and Water Conservation Districts of Montana provided funding, as well as advice and feedback. Kristy Fortman and Mark Ockey of Montana Department of Environmental Quality provided guidance and information during the process, as did Traci Sylte and Dustin Walters of the Lolo National Forest. Jed Whiteley, Will McDowell and Katie Racette at the Clark Fork Coalition provided input and reviewed the draft, as did Heather Barber of the Bitterroot Water Forum, Ladd Knotek of Montana Fish, Wildlife and Parks, Jen McBride of the Missoula Conservation District, Rob Roberts of Montana Trout Unlimited and Brian Sugden of Weyerhaeuser. Jim Nave of Montana Department of Natural Resources and Conservation, Water Resourced Division provided insight into water use within the watershed. Many residents and landowners provided feedback by completing and submitting surveys or through meetings and/or fieldtrips. Denny Anderson of Spooner Creek Ranch, Bart Morris of Oxbow Cattle Company, MPG Ranch, and staff from Montana Nature Conservancy, Five Valleys Land Trust and Northwestern Energy all offered time and information about the watershed and their operations. These contributors all helped to make this a better plan.

Table of Contents

Introduction

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 the city of Missoula (Figure 1). The watershed encompasses 47.9 square miles and supports a variety of land uses, from silviculture and agriculture, to residential subdivisions. The watershed has been undergoing many changes in land use and ownership in recent decades, and this presents challenges and opportunities for management and restoration.

The Missoula Valley Water Quality District (MVWQD) is a local government agency charged with protecting and improving the quality of surface and groundwater within the district boundaries. MVWQD works with interested landowners and partnering agencies and organizations to conduct on-the-ground restoration work as well as educating residents on the importance of watershed health in protecting water quality. The District also collects surface and groundwater data to assess water quality and develops programs to detect and remedy contamination.

The goal of this Watershed Restoration Plan (WRP) is to present a broad framework to guide property owners and restoration organizations in developing and implementing projects that can make meaningful, measurable improvements to the condition of Miller Creek in the coming years.

This WRP was developed using the "Nine Minimum Elements of an Environmental Protection Agency (EPA) Watershed Restoration Plan" and guidance from the Montana Department of Environmental Quality (DEQ) (Figure 2).

The process of engaging local stakeholders took place in several ways. MVWQD conducted one-on-one interviews with major landowners including United States Forest Service (USFS), The Nature Conservancy, Northwestern Energy and three large ranch owners. Additional outreach was conducted using a postage-paid mail-in survey which was mailed out to any entity or individual that owned property adjacent to Miller Creek. Approximately 200 of these surveys were mailed out and 59 were returned (29.5% participation). This survey asked residents what they valued most about the watershed, and what changes they had observed (positive and negative). Residents were also asked about projects (riparian restoration, weed treatment, beaver re-introduction) that they would consider undertaking on their properties. Additionally, stakeholders such as the Montana Department of Natural Resources and Conservation (DNRC) Water Resources Division, Montana Fish Wildlife and Parks (FWP), Missoula Conservation District were contacted via phone and email for comments and thoughts about Miller Creek.

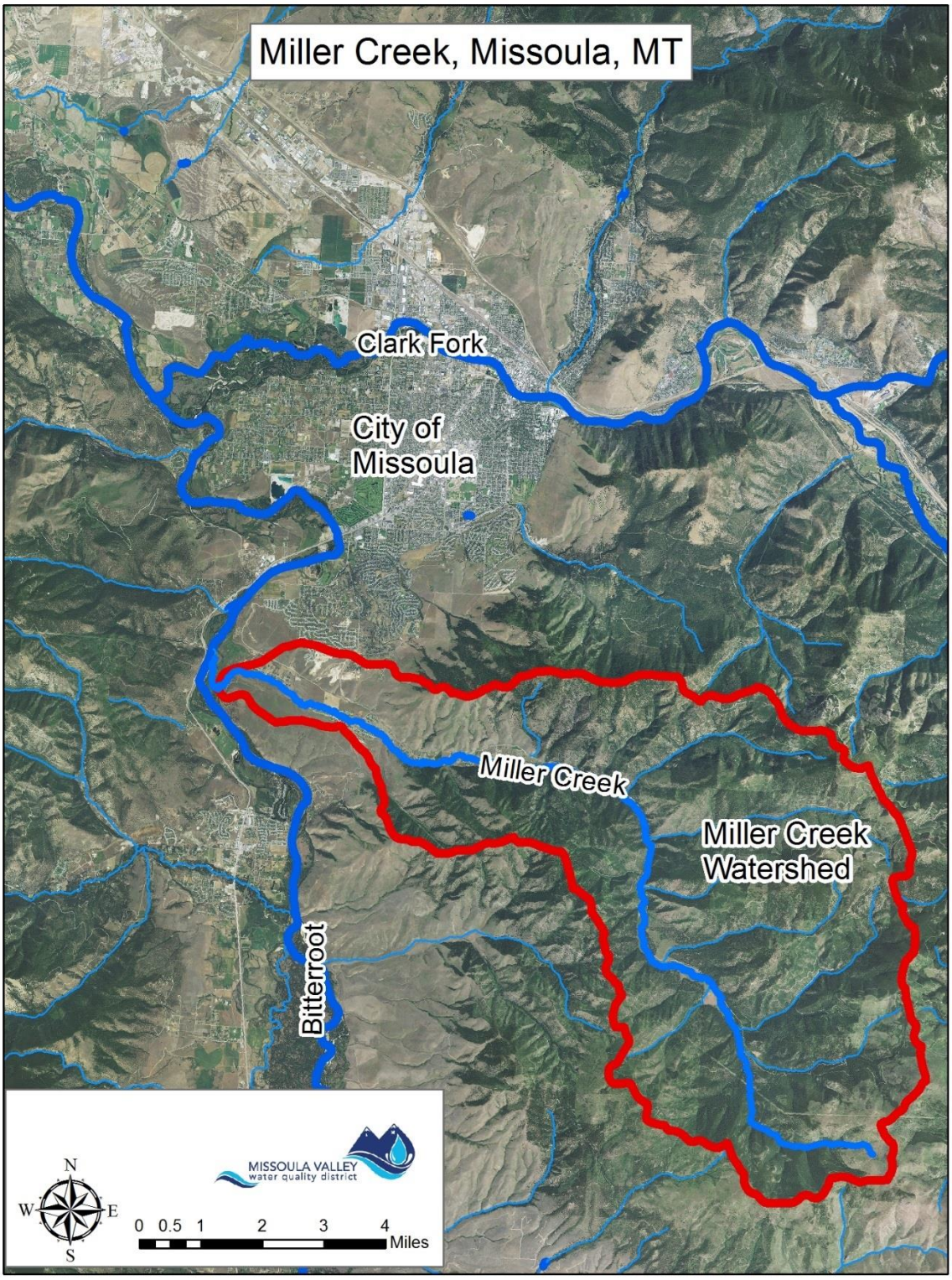


Figure 1: Miller Creek watershed

Environmental Protection Agency Nine Elements of a Watershed Restoration Plan

a. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.

b. An estimate of the load reductions expected from management measures.

c. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.

d. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

e. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

f. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

g. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above.

Figure 2: EPA Nine Minimum Elements

Description of the Watershed

Silviculture is the dominant land use type within the Miller Creek watershed, with growing residential development along its lower reach (Table 1, Figure 3).

Table 1. Dominant Miller Creek Watershed Land Use

Property Type	Acres	Percent
Forest/Prairie	27399.87	89.83%
Agricultural (Valley Floor)	1026.50	3.37%
Residential	1988.62	6.52%
Total	30500.36	

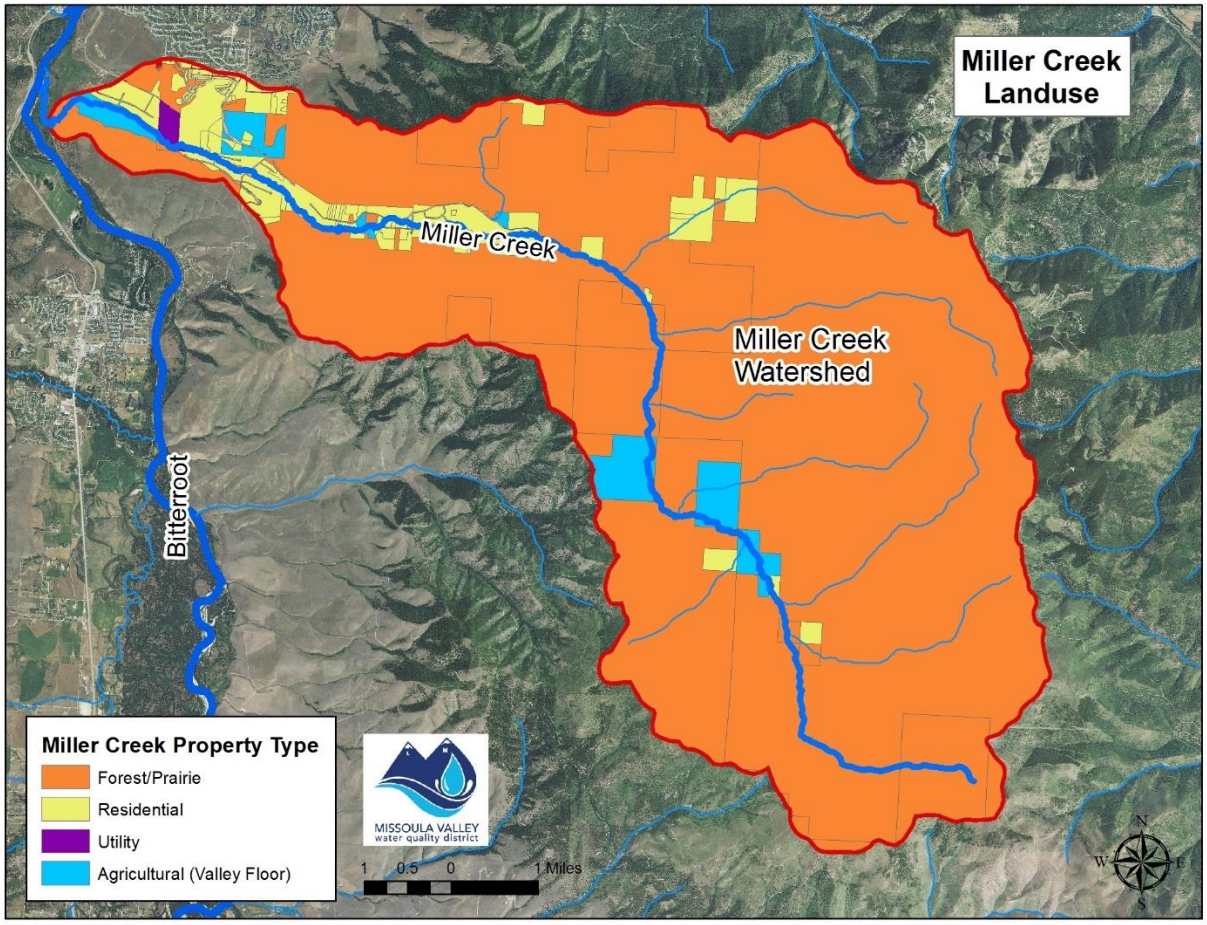


Figure 3: Miller Creek Land Use

With the exception of Weyerhaeuser land in the uppermost 1 mile of the stream which burned in 2003 and is regenerating, the upper 4 miles of the watershed are in excellent condition and exhibit little or no impairment. These areas will need to be protected, to prevent degradation, as the growing population in Miller Creek and beyond increases recreational pressure. Partnering with USFS and private forest owners will be important to ensure that these areas of the watershed are preserved (and improved, where needed), into the future.

As of the 2010 census, approximately 2,695 people live within the Miller Creek Watershed. This number is expected to more than double as two major subdivisions are expected to be completed totaling more than 1500 new homes by 2030 (Linda Vista Estates and Teton Addition Phasing Amendments, 2015)

According to a FWP fisheries biologist, the middle and lower perennial sections are dominated by rainbow trout/westslope cutthroat trout hybrids in addition to brook trout, with some brown trout in lower reaches (Knotek 2016 email). There is seasonal and limited connectivity with the Bitterroot River for migratory fish. In general, as one moves upstream into headwater tributaries, the proportion, density and genetic purity of westslope cutthroat trout (WCT) increases with some tributaries having only genetically pure WCT. According to FWP, road issues are of significant concern to fisheries within

this watershed (undersized, malfunctioning culverts and contribution of sediment from roads) (Figure 4). Fish passage obstructions in the watershed need to be assessed and a plan for mitigation developed and implemented (Knotek, 2017).

Figure 4 Miller Creek Headwaters: Though the headwaters are relatively healthy, undersized culverts carry high velocity flows that serve as a barrier to fish migration

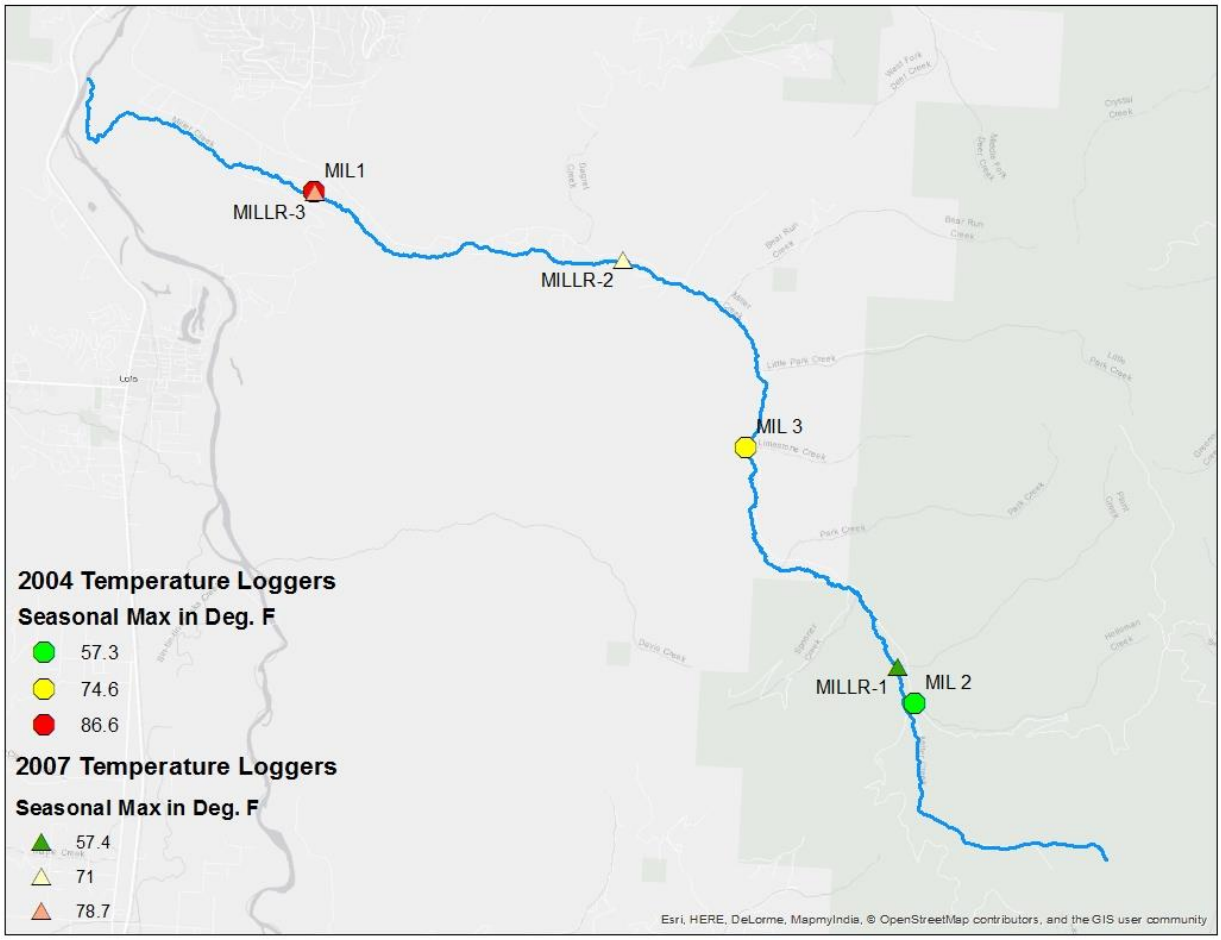
Impairment Causes and Pollutant Sources

(EPA Element a)

Miller Creek is listed for temperature and sediment impairments on the 2016 Clean Water Act section 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. For all impaired water bodies in the state, the DEQ determines total maximum daily loads (TMDLs) of pollutants that need to be met in order for all beneficial uses to be supported. The status of Montana's waters is updated biennially by the DEQ in the Integrated Report. The Bitterroot TMDL document (DEQ, 2011), which includes Miller Creek, guided the development of this WRP.

Temperature

In 2007 and 2004, the DEQ conducted assessments at three sites on Miller Creek (Figure 5). Each showed measurable increases in stream temperature from up-gradient to down-gradient locations (Table 2). A thermal infrared flight (TIF) in 2004 also documented a rise in stream temperature. Monitoring in the warmest reaches of the stream showed 47 days with temperatures above 70 degrees Fahrenheit. This trend continues until Trails End Road, where most of the remaining warm water is diverted for irrigation. Groundwater and springs enter the stream below Trails End Rd, which sustains the creek until it disappears below the stream bed. The lower three miles of the stream often do not flow year-round.



(MT DEQ, 2011)

Figure 5: Miller Creek Temperature Monitoring Locations; 2004 & 2007

Table 2. Temperature Data Summary								
SiteID	Seasonal Maximum		7-Day Average During Warmest Week of Summer				Days>	Days>
	Date	Value	Date	Daily Max	Daily Min	Delta T	59 °F	70 °F
Mil1	08/17/04	86.6	08/14/04	81.9	54.6	27.3	44	38
Mil2	07/17/04	57.3	08/14/04	55.9	48.4	7.6	0	0
Mil3	07/17/04	74.6	07/26/04	71.6	49.9	21.7	43	24
MILLR-1	07/28/07	57.4	07/28/07	56.7	50.0	6.7	0	0
MILLR-2	07/18/07	71.0	07/17/07	69.5	54.4	15.1	53	3
MILLR-3	07/28/07	78.7	07/28/07	76.5	58.5	18.0	69	47

The QUAL2K model was used to estimate anthropogenic causes of impairment in the Total Maximum Daily Load document (TMDL).The model indicated that the two major factors impacting stream water temperatures are shading from riparian vegetation and instream flow volume.

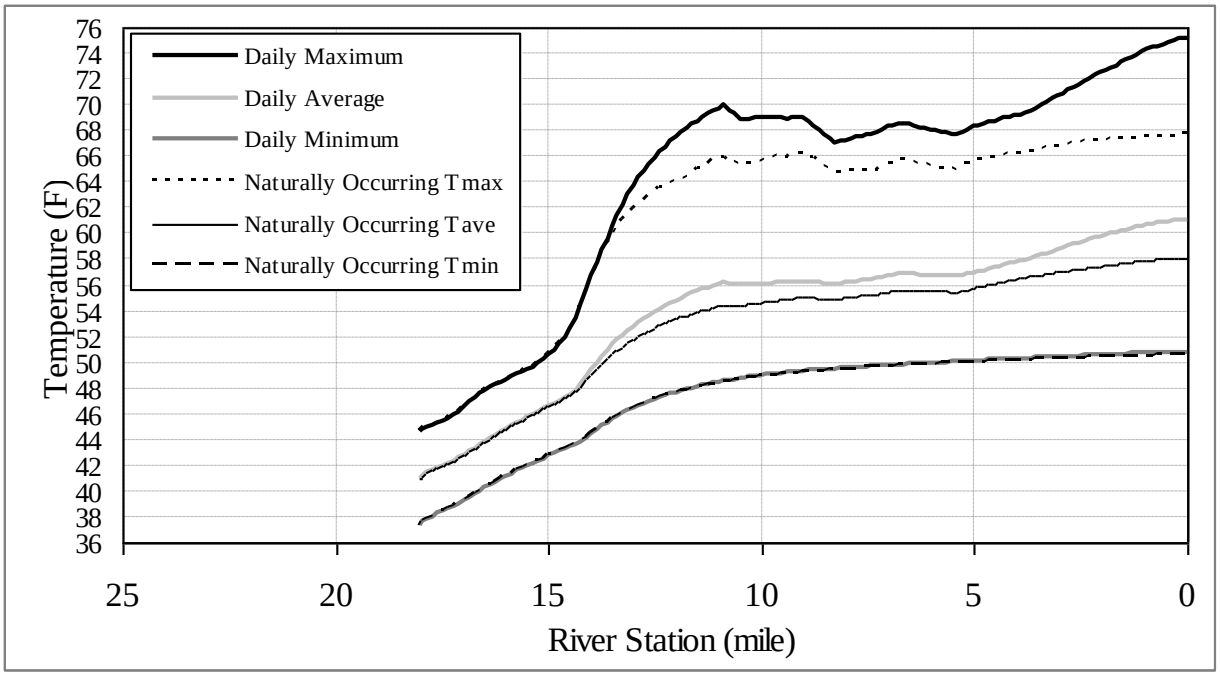


Figure 6: Model scenario results show impacts from irrigation diversions and riparian degradation in lower miles (MT DEQ, 2011)

Riparian and Stream Channel Conditions

In 2007 the DEQ conducted riparian assessments along each 500 meter section of the stream using aerial photography and stereoscope. From this assessment, effective shade percentage was developed along with a target condition (Figure 7).

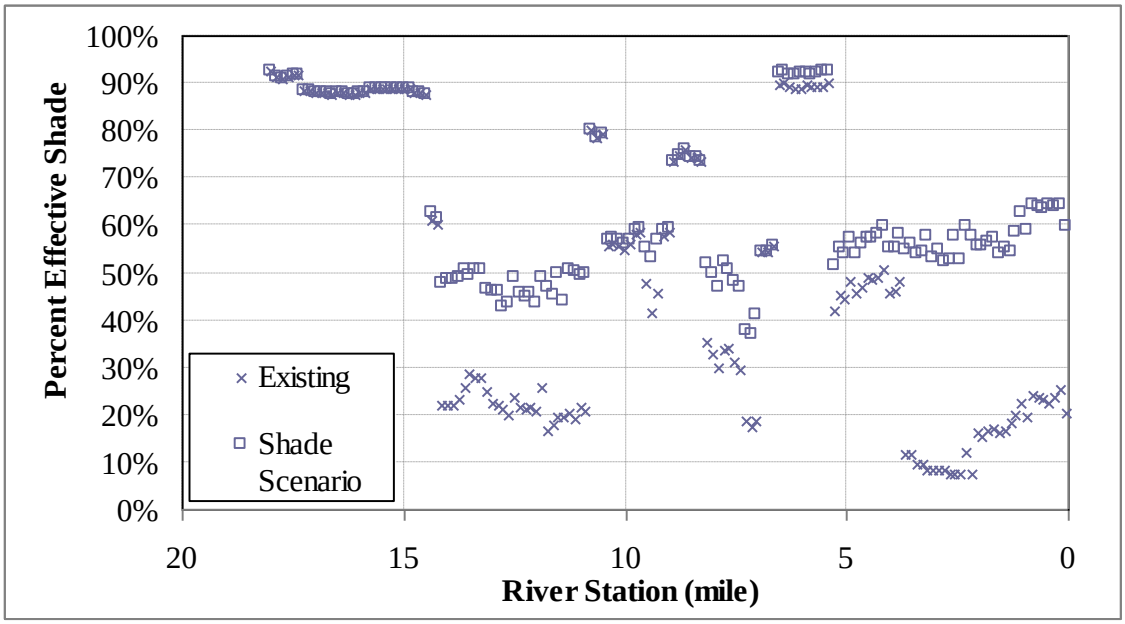


Figure 7: Existing vs potential shade (MT DEQ, 2011)

Daily effective shade ranged from 92% in the headwaters to 7% in the lower reaches. Because the creek is narrow, shading has a large effect on water temperature. Upstream reaches of riparian vegetation consist of douglas fir, ponderosa pine, dogwood, aspen and other native riparian species. Middle and lower reaches are dominated by irrigated fields and lawns. As agricultural practices have shifted from cattle production, some natural recruitment of native species has occurred. This has, however, coincided with invasive weed infestations. Average shade conditions in 2007 were estimated to be 48%. Restoring riparian vegetation to increase shade coverage to 65% would lower stream temperatures by an estimated 7.5^0 F.

The major human impacts reducing shade cover identified in the TMDL (DEQ, 2011) include livestock grazing and hay production in miles 0-4 and 11-15. Grazing and suburban developments are the primary impacts from miles 4-11.

Irrigation Water Use

The TMDL document identifies irrigation as a potential contributing factor to high stream temperatures. According to the model output, from stream mile 4-14, maximum stream temperatures during summer months were found to deviate significantly from naturally occurring maximum temperatures Figure 8.

Irrigation diversions may exacerbate warm temperatures by lowering instream flow. Lower stream flows become more easily warmed as the temperature buffering capacity is inhibited. Also, the water used for irrigation is often warmed when it is applied to the land surface, raising the stream temperature when it re-enters as return flow. Since this temperature assessment and model were completed, surface water withdrawals have changed. Nine of the lower-most surface water irrigation rights were retired in 2014 to mitigate impacts of public drinking water supply development in the lower watershed. 2017 withdraws from this well field total 187 acre feet with an allowed withdrawal up to 623 acre feet per year (Mountain Water Change of Use Application, DNRC page 38). As this area becomes more

developed, groundwater withdrawals could increase by 70% from the new public water supply well field consisting of three wells located in the alluvium at the mouth of Miller Creek. Miller Creek is hydraulically disconnected from groundwater over much of its course, and loses water rapidly through a highly permeable bed (Hewitt, 2004); Because of this disconnection, groundwater withdrawal is not projected to affect Miller Creek (Mountain Water Change of Use Application, DNRC page 25). To mitigate effects on the Bitterroot drainage as a whole, nine surface water irrigation rights on Miller Creek were retired, removing 345 irrigated acres from the watershed. These mitigation efforts may improve in-stream flow and thus reduce temperature. These nine retired water rights are the most senior in the drainage with priority dates of June 1, 1877, June 7, 1878 and September 1, 1878.

Developing a drought management plan in this basin may be beneficial in reducing temperature on Miller Creek. Climate change could play a major role in the temperature and flow profile of Miller Creek in the coming decades, making a drought management plan even more important. Also, temperature targets may need to be reevaluated in coming years to account for possible climatic changes.

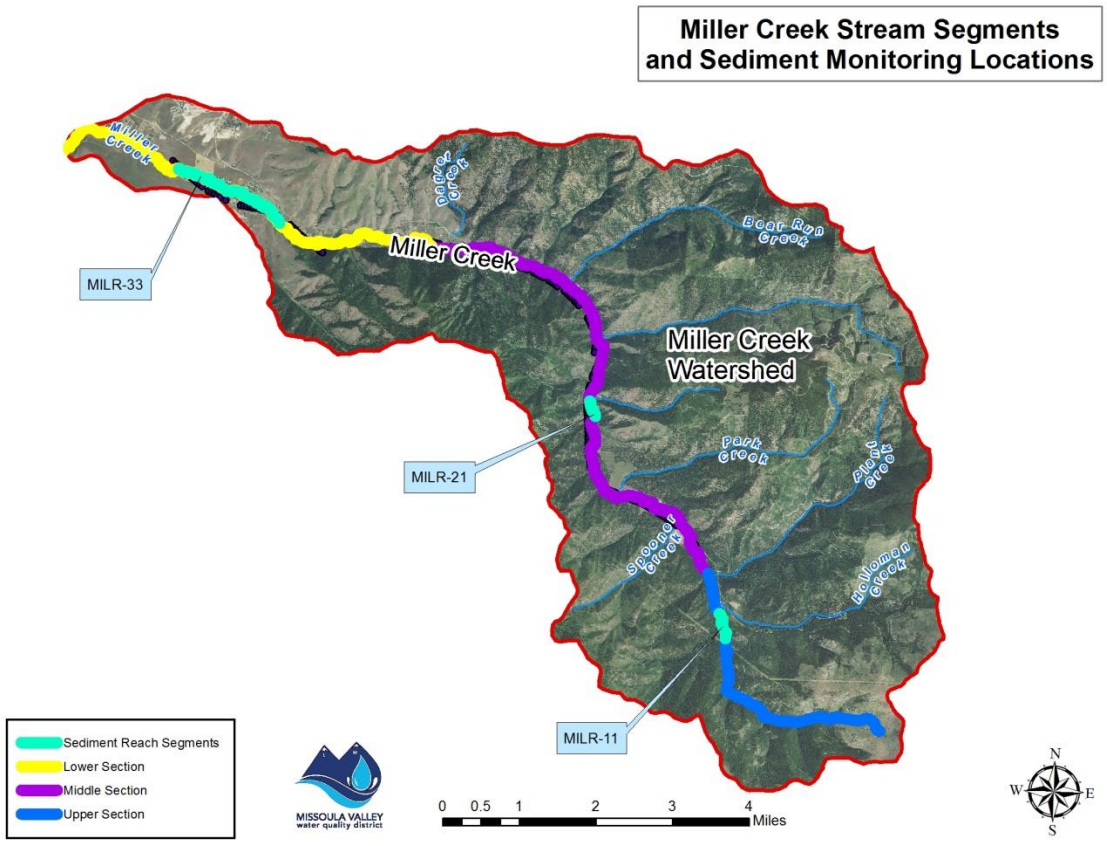


Figure 8: Sediment Monitoring Locations and Identified Stream Segments

Sediment

The Department of Environmental Quality (DEQ) carried out sediment assessments for the TMDL in 2007 at three locations (Figure 8). The upper reach was mainly coniferous forests with dense underbrush, and channel morphology was largely intact with no active erosion identified. Large woody debris provided pools with potential spawning gravels. This segment was classified as a potential Rosgen B4 channel type. The middle reach flows through meadows that showed evidence of recent logging and agricultural use. The channel was over-widened, and significant erosion was identified on the outside of meander bends. There were some pools at meander bends. Mostly grasses and wetland vegetation were found along the banks. This segment was classified as a potential Rosgen C4 channel. DEQ assessors described the lower segment of Miller Creek as "one continuous riffle" with no pools or large woody debris. The stream flowed through open space and suburban neighborhoods, and vegetation was primarily grass and weeds. (DEQ, 2011) (Table 4).

Table 4. Sediment and Habitat Data Compared with Targets
(Bold values indicate targets not met)

Reach	Mean BFW (ft)	Level III Ecoregion	Potential Stream Type	Riffle Pebble Count (Mean)		Grid Toss (Mean)		Channel Form (Median)		Instream Habitat			Riparian	Sediment Source
				% < 6 mm	% < 2 mm	Riffle % < 6mm	Pool % < 6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools/Mile	LWD/Mile	Greenline % Shrub Cover	Riffle Stability Index
Milr-11	8.2	MR	B4	**27**	10	**21**	**11**	9.8	5.0	**0.6**	148	**570**	86	NC
Milr-21	23.5	MR	C4	**32**	**12**	**15**	**20**	**31.3**	3.9	**1.0**	69	**222**	**7**	NC
Milr-33	28.6	MR	C4	**24**	**14**	**24**	NC	**48**	5.1	**0.0**	**0**	**9**	**20**	NC

(MT DEQ, 2011)

Miller Creek has many sections where banks appear to be eroding excessively. This is the major source of sediment to the stream (DEQ, 2011).

An additional source of sediment is roads. Paved roads can contribute sediment when sanded during the winter months. Unpaved roads, such as the upper portion of Miller Creek Road, private drives, and forest management roads can contribute sediment to the creek and its tributaries throughout the year, especially during higher-intensity convective runoff events (Sugden and Woods 2007). In addition, stormwater runoff from road or other construction projects can carry sediment to the creek unless appropriate best management practices (BMPs) are implemented.

Load Reduction Estimates and Non-Point-Source Management Measures

(EPA Elements b and c)

Temperature

"The most influential non-point source restoration strategy for Miller Creek will be restoring shade-producing vegetation along the whole segment."
Miller Creek TMDL (2007)

During the summers of 2004 and 2007, the DEQ monitored instream temperature at three different locations. 2007 data showed the upper sections of the stream to be cool with a gradual warming in the middle section. The lower mile of Miller Creek experiences significant heating. A thermal infrared flight during the 2004 field season showed a similar warming trend from upstream to downstream on Miller Creek (Figure 9). This temperature gradient also corresponded well to riparian vegetation surveys (Figure 10).

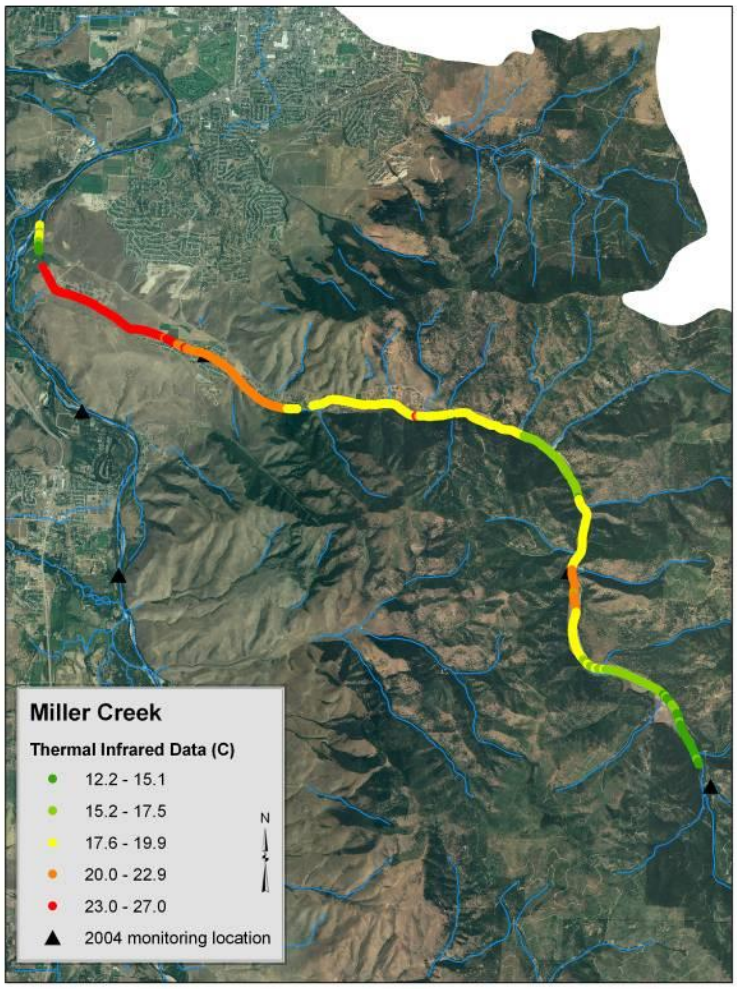


Figure 9: FLIR Stream Temperature Profile 2004 (MT DEQ)

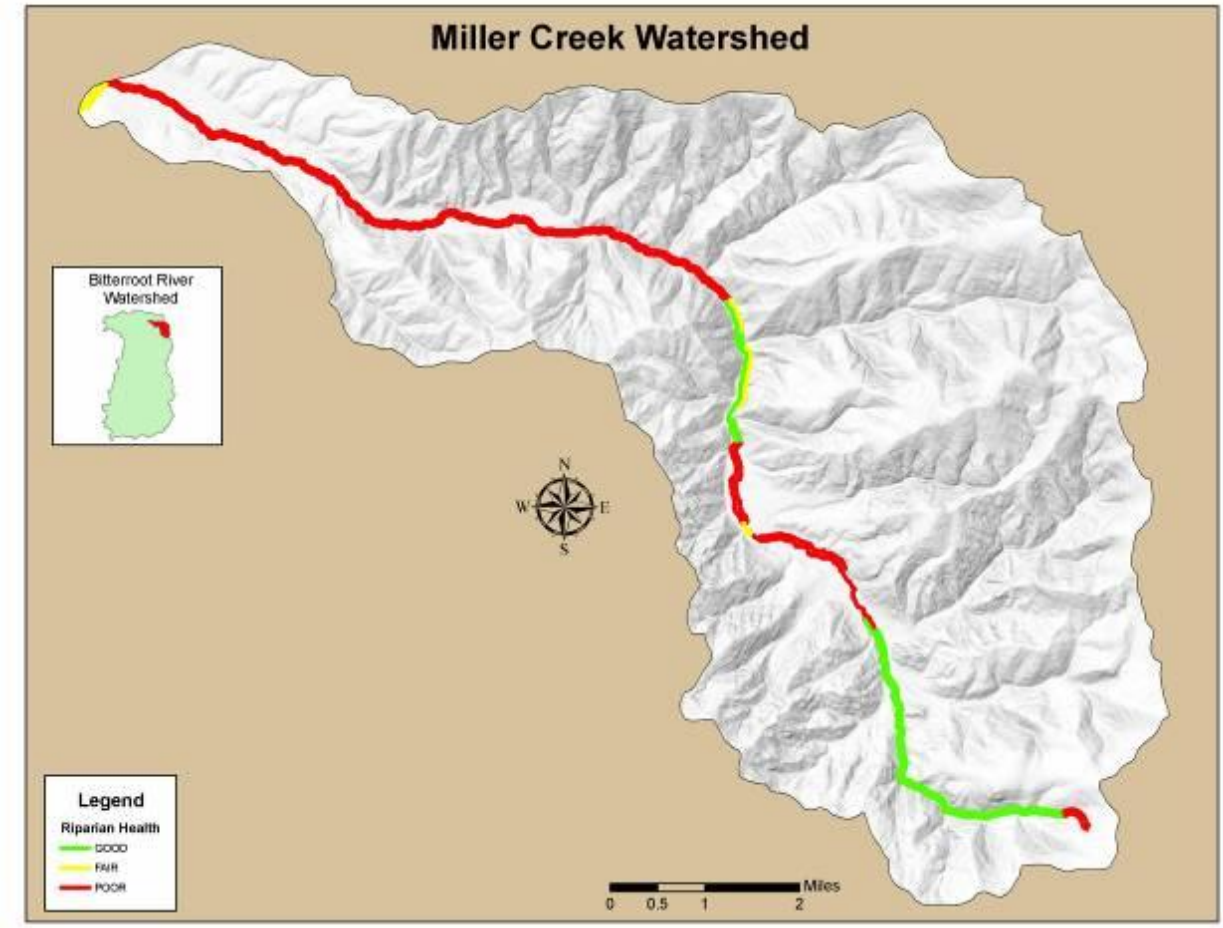


Figure 10: 2007 Riparian Conditions (MT DEQ)

Table 3. Temperature Target and Existing Conditions		
Water Quality Targets	Criteria	Existing Condition
Maximum allowable increase over naturally occurring temperature	B-1 Waters: 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F – 66°F; within the naturally occurring range of 66°F – 66.5°F, no discharge is allowed that will cause water temperature to exceed 67°F; where naturally occurring water temperature is >/= 66.5°F, maximum allowable increase is 0.5°F.	QUAL2K modeling indicates Montana's temperature standard is not being met during average summer afternoon conditions. If conditions provided below for sources are met, daily maximum summertime temperatures would likely be reduced by at least 8°F.
OR meet ALL of the temperature influence restoration targets below		
Effective Shade	65% Effective Shade	48% Effective Shade
Channel Width/Depth Ratio	</= 16	9.8 – 48
Irrigation Water Management	15% improvement in irrigation efficiency with water saving applied to in-stream flow mid-June through August.	Irrigation systems need to be assessed on a case-by-case basis.
Irrigation Return Flow	Reduce warm return irrigation water entering stream by 75%.	Unknown

(From Bitterroot TMDL, MT DEQ, 2011)

High temperatures on Miller Creek correspond directly to poor riparian vegetation conditions. A 2005 survey of the banks and adjacent property found that 72% of streambank along Miller Creek had significant anthropogenic effects within 100 feet of the channel. 74% of the banks' riparian areas (27 miles) were rated in fair or poor condition. The focus for watershed restoration on this stream will be improving riparian health. However, other restorative techniques will reduce thermal load to the stream. There are three primary methods for improving temperature conditions on Miller Creek:

- Improve and protect riparian vegetation
- Increase flow
- Improve channel morphology in lower reaches through addition of meanders and woody debris

Increasing stream flow through irrigation efficiency and instream flow leases will put more water in the stream and bring temperatures down. Reducing warm-water irrigation returns may also help mitigate temperature impacts in some locations.

Figure 11: Lower section of Miller Creek was straightened by previous owners and large trees removed.

Physical assessment of the stream shows the lower reach to be partially channelized and separated from its floodplain by low berms in places (Figure 11). The lower reach is starved of large woody debris and is comprised of one continuous riffle. To restore this section of Miller Creek, a combination of fencing, revegetation, addition of large woody debris, passive restoration by elevating the stream bank through use of beaver analogs, and capturing and dispersing sediment will improve both sediment and temperature conditions. Relocation of the stream in order to reconnect it to its floodplains may be necessary in certain reaches. Increasing effective shade to 65% should result in a reduction of stream temperatures by 7.5-8 degrees Fahrenheit, according to the TMDL (DEQ, 2011). Consequently, a major goal of this WRP is to make progress toward achieving 65% effective shade per mile of stream. This will be focused in the lower and middle stream sections, where degradation of riparian vegetation and elevated temperatures are most severe. Physical assessments in the middle section of the stream noted that the stream was overly-wide due to grazing. Some important ways to improve temperature and sediment in these areas are through streamside protection efforts such as providing a buffer between tilled or grazed land and the stream using fences or management practices, and actively replanting some areas where natural regeneration is not likely to be successful in a reasonable timeframe. Some stretches of Miller Creek have conservation easements in place, and finding additional areas for protection could help achieve restoration goals. Planting projects carried out over the larger scale of agricultural lands can be challenging due to the need for watering, weeding and other maintenance for several years. Fencing and other management practice changes that allow natural regeneration may be more feasible and cost effective in many of these areas.

In residential areas, homeowners can be engaged to plant riparian vegetation and/or stop mowing along their stream segment. Providing technical assistance, matching grants and possibly coordinating volunteer labor would facilitate projects on residential lots. Homeowners could then provide for watering and maintenance of the restored vegetation. Technical assistance could help them identify native species that would work well in their landscape. There are three designated common areas that are owned by homeowners associations or the county within the middle reaches that would be ideal targets for restoration efforts (Figure 12).

Figure 12: Common Area of Stillwater Subdivision

Sediment

The major sources of sediment to Miller Creek (Table 5) – eroding banks, roads (including sanding and agricultural access (Figure 13)) and stormwater runoff– can be addressed by a number of restoration measures (Table 6). Many of the measures implemented to address temperature impairment, discussed above, would also be effective in reducing sediment loads to the stream. The primary measures that will be used to address sediment in Miller Creek are:

- Allowing riparian vegetation to regenerate naturally, and/or planting new vegetation where needed
- Modifying channel structure to create more stable banks, and allow access to floodplain (including beaver/beaver mimicry structures and/or woody debris structures)
- Decommissioning unneeded forest roads
- Implementing stormwater BMPs
- Improving agricultural stream crossings
- Upgrading or removing under-sized culverts

Figure 13: Agricultural creek crossing introduces sediment into Miller Creek

Planting and regeneration of riparian vegetation helps to stabilize banks and reduce excessive erosion. Beaver mimicry structures can help slow flow and create areas of aggradation, reducing sediment loading downstream. There are also some locations, including one near the intersection of Horseshoe Lane and Singletree Lane, where it appears the creek has avulsed and lost one or more meanders, due to some combination of flooding and informal flood mitigation (berms and channelization) measures, resulting in instability and excessive erosion. Restoring meanders and woody debris to the system will improve both temperature and sediment regimes.

Decommissioning forest management roads that are no longer needed in the watershed could reduce sediment loading to the creek depending on their condition and proximity to streams. The major forest road landowners and agencies do not have near-term plans for decommissioning, but working with these parties to prioritize and implement decommissioning will be important in the coming years, and at least one landowner has expressed an interest in exploring decommissioning. Water Erosion Prediction Project (WEPP) or USFS Geomorphic Road Analysis and Inventory Package (GRAIP) modeling could be used to help prioritize roads for decommissioning.

Another important periodic source of sediment is stormwater runoff. As the population in Miller Creek is projected to double by 2031 (Linda Vista Estates and Teton Addition Phasing Plans (2015) and adherence to stormwater permit provisions will be important to prevent impacts from construction activities and increase non-point source stormwater runoff as development continues in this fast-

growing area. As this area develops, it will also be important to plan for and mitigate effects of increased impervious area and increased stormwater runoff.

Table 5. Existing and Allowable Sediment Loads				
Sediment Sources		**Current Estimated Load (Tons/Year)**	**Total Allowable Load (Tons/Year)**	**Sediment Load Allocation (% Reduction)**
Roads		27	10	63%
Eroding Banks	Anthropogenically Influenced	1415	792	30%
	Natural	659	659	
Upland Erosion	All Land Uses	131	77	41%
Total Sediment Load		2232	1538	31%

(From Bitterroot TMDL, MT DEQ, 2011)

Temperature and Sediment Restoration Activity

Temperature and Sediment reductions will be primarily addressed through improvement of channel morphology, addition of woody debris to encourage a more natural sediment regime and restoration of riparian vegetation. Restoration measures are outlined in Table 6.

Table 6. Nonpoint Source Management Measures Needed To Address Temperature and Sediment Impairment	
Stream Reach (Mile)	**Restoration Activities**
0-5	Beaver Analog Riparian Planting Irrigation Efficiency Improve channel structure
5-10	Beaver Analog Riparian Planting Improve channel structure
10-15	Riparian Planting Riparian Fencing Decommissioning forest roads Improve channel structure Removing fish-passage barriers
15-18	Decommissioning forest roads Removing fish-passage barriers

Public Outreach and Education

(EPA Element e)

MVWQD met with landowners and in some cases visited properties to see previous restoration projects and get input on priorities for their land and the watershed as a whole. In addition, all landowners living along Miller Creek were sent a letter and survey to introduce the watershed planning process and to get their input regarding what they most value about Miller Creek, and what they think are the major challenges and priorities for the watershed. They were also asked whether or not they would be interested in participating in restoration activities on their land. This input was used in developing this WRP and will be used to identify restoration opportunities when the plan is implemented. The response

rate for this survey was 29.6%. Respondents could select as many values, concerns and restoration interests as desired, so percentages do not add up to 100. The top values that were reported in the survey were scenic (59%) and wildlife (57%). The top issues that respondents felt needed to be addressed were lack of streamside vegetation (45%), low stream flows (38%) and weed management (51%). 83% of survey respondents were willing to participate in restoration activities of some sort on their own property. The projects that garnered the most interest were weed management, stream flow enhancement projects and streamside vegetation restoration. Complete survey results can be found in appendix A.

Future outreach and education activities will be carried out periodically to keep the community informed of the importance of restoration, to encourage participation in restoration activities and to highlight progress toward restoration goals over time. MVWQD has previously carried out education activities in the Miller Creek watershed, and other watersheds, and will continue to provide education and outreach. However, establishment of a citizen-based watershed group for Miller Creek would be a more effective and participatory way to provide ongoing outreach and collective energy for restoration implementation. Alternatively, an existing organization could provide these services. MVWQD will explore interest and capacity for citizen involvement through a new or existing organization as implementation of the restoration plan gets underway.

Education and outreach strategies may include:

- Establishing Miller Creek watershed group or Miller Creek focus within existing group.
- Establishing Facebook page for Miller Creek.
- Presenting to homeowner associations regarding condition issues in the watershed and restoration opportunities for individual properties and common areas.
- Targeted mailing with information on restoration opportunities.
- Restoration project tours to highlight successful efforts in the watershed.
- Engaging students in restoration projects

Table 10. Education and Outreach Activities

Activity	Potential Partners
Miller Cr. Watershed Group	MVWQD, CFC
Miller Creek Facebook Page	MVWQD, new group, CFC
Present to HOAs	MVWQD, CFC, New group
Targeted Mailing	MVWQD
Project Tours	Property owners, MVWQD, CFC, New group
Engage primary/secondary students in restoration	CFC, Watershed Education Network (WEN)

Implementation Schedule

(EPA Element f)

Table 7 shows the proposed schedule for implementation of non-point-source management measures needed over the next five years to progress toward achieving load reductions required by the TMDL. Most of the listed measures will address both sediment and temperature. This schedule is an initial estimate of measures that are achievable in the coming years, and will be modified as restoration progresses. Watershed planning is a dynamic process that evolves as new information becomes available, as opportunities arise and as stakeholder priorities change.

Table 7. Implementation Schedule

Restoration Activity	T	S	H	2018	2019	2020	2021	2022	2023 -
Stream assessments	X	X	X						
Riparian planting	X	X	X						
Riparian Fencing	X	X	X						
Beaver/Beaver Analog Structures/Woody Debris	X	X	X						
Channel Structure Work	X	X	X						
Fish Passage Work			X						
Facilitate Watershed Group Formation	X	X	X						
Presentations to HOAs	X	X	X						
Student restoration work	X	X	X						
Road Decommissioning		X	X						

[T (temperature), S (sediment) or H (habitat) indicates impairments/issues that will be addressed]

Measurable Milestones

(EPA Element g)

Milestones represent targets for the first five years of implementation of WRP. These targets are based on prioritizing the most impacted reaches of the creek, and also potential opportunities for collaboration with interested partners, such as property owners (PO), homeowner associations (HOA), the Clark Fork Coalition (CFC), Trout Unlimited (TU), the Bitterroot Water Forum (BWF) and the Missoula Conservation District (MCD) (Table 8).

Table 8. Measurable Milestones

Milestone	Objective	Segment	Possible Partners
Plant 2500 native riparian trees and shrubs	Reduce summer temperature; provide woody debris; reduce bank erosion; improve channel structure/function	Mile 0 – 3 (from mouth)	HOAs, CFC, BWF, POs
Plant 5000 native riparian trees and shrubs	Reduce summer temperature; provide woody debris; reduce bank erosion; improve channel structure/function	Mile 3 – 10	HOAs, CFC, BWF, POs
Install 4000 feet of riparian fencing	Allow regeneration of riparian vegetation	Mile 0 – 10	BWF, MCD
Install 12 beaver analog structures	Storage; reduce summer temperature; improve channel structure/function; reduce sediment load	Mile 0 – 10 (from mouth)	BWF, CFC, TU, POs
Install irrigation efficiency infrastructure at 2 locations	Increase flow; decrease temperature	Mile 0 – 10 (from mouth)	MCD, CFC, BWF
Reconfigure avulsed section of creek	Improve channel structure/function; reduce bank erosion.	Mile 5 – 10	CFC, Missoula County
Present to 2 HOAs regarding restoration opportunities	Provide education regarding restoration objectives and opportunities		BWF, HOAs
Facilitate formation of Miller Cr.	Provide ongoing grassroots organization to		CFC, BWF, HOAs, POs

watershed group, or inclusion of Miller Cr. focus in existing group	prioritize projects and energize local residents to pursue restoration activities		
Engage 2 classes of students in restoration	Provide education on riparian vegetation and stream health.	0 – 10	CFC, WEN

Resources Needed

(EPA Element c)

Restoration costs are variable, depending on several factors. For example, buying, planting and maintaining new riparian vegetation can be expensive, whereas changing management practices so that vegetation can naturally regenerate over time could be much less expensive. Some organizations have significant volunteer pools that can provide free or low-cost technical assistance and labor, and for smaller scale actions in urban areas, homeowners may be able to provide their own labor and maintenance. Restoration strategies and activities will vary, depending on the needs of each restoration project, and the resources available to those carrying out the restoration.

This WRP provides an estimate of resources needed for different methods at the scales needed to achieve the WRP goals. Table 9 shows estimated resource needs for different restoration activities.

Table 9. Resources Needed

Measure	Treatment Cost per Unit	Units Needed for Goal	Total Cost	Potential Funding Sources
Road assessment and decommissioning	$10,000-$14,000/mile	unknown	n/a	USFS Partnership Grant DEQ 319, SWCDM Ranching For Rivers
Stream Assessment and Prioritization	$10,000	1	$10,000	DNRC Watershed Mgmt. Grant, NFWF Five Star, Trout Unlimited (TU), Montana DNRC Renewable Resource Grant and Loan, Private Funders
Beaver analog structures	$0 - $500 each	unknown	n/a	DEQ 319 Natl. Fish & Wildlife Fndn. (NFWF) Five Star Grant, Private Funding
Vegetation planting (incl. weed/browse protection)	$15 - $20/plant	7,500	$112,000 - $150,000	DEQ 319 NFWF Five Star, Missoula Conservation District, MVWQD, SWCDM Ranching for Rivers
Channel morphology work	$50 - $100/foot	Unknown	n/a	DNRC Watershed Mgmt. Grant NFWF Five Star, Trout Unlimited (TU), Montana DNRC Renewable Resource Grant and Loan
Culvert replacement	$27,000	unknown	n/a	FWP Future Fisheries Grant, Trout Unlimited,
Riparian fencing	$2-$7 per foot	2 - 5 miles	$8,000-$80,000	SWCDM Ranching for Rivers Grant, NRCS EQIP, DEQ 319
Irrigation Efficiency	$10-$50K per project	Unknown	n/a	NRCS EQIP, DNRC RRGL

Technical Assistance

Technical Assistance may be provided by the following:

- Fish Wildlife and Parks Biologist – Fisheries improvement and monitoring
- Missoula County Weed District – Weed management
- Missoula Valley Water Quality District – Groundwater/surface water interactions and restoration
- Clark Fork Coalition – Monitoring and Restoration methodologies, Road Decommissioning
- Trout Unlimited – Fisheries
- Bitterroot Water Forum – Restoration Methodologies
- Lolo National Forest – Hydrology
- DEQ Water Quality Specialist – Water Quality Monitoring
- Missoula Conservation District – Irrigation, Fencing, Agricultural practices

Monitoring Plan and Criteria for Measuring Progress

(EPA Elements h and i)

Information about restoration projects implemented will be tracked and compiled for the entire watershed. Monitoring will be conducted prior to and after restoration project implementation to assess the effectiveness of restoration strategies and guide future projects. Monitoring after restoration will take place at an interval appropriate to the practice to identify improvement over time, and will vary depending on the setting and method used.

Achievement of restoration objectives will be measured over time using the criteria outlined below, as well as additional criteria that may emerge, as restoration progresses.

Temperature Monitoring

Temperatures will be monitored periodically at the locations and approximate dates that were monitored for TMDL development, as well as above and below restoration sites, before and after restoration, when the restoration activity is anticipated to mitigate temperatures. Infrared surveys could be conducted as well if funding becomes available.

Sediment Monitoring

The following parameters were selected based on TMDL methodologies, and will be measured and compared to TMDL targets:

- Riffle Pebble Count using Wolman Pebble Count Methodology and/or 49-point grid tosses
- Residual Pool Depth Measurements
- NRCS Proper Functioning Condition (PFC)
- Bank Assessment for Non-point source Consequences of Sediment (BANCS) model/BEHI – Bank Erosion Hazard Index

Table 11. Monitoring			
Parameter	**Methods**	**Responsible Parties**	**Costs**
Temperature	Direct Measurement including synoptic Infrared Surveys	MVWQD CFC	$40 - $60/hour
Sediment	Riffle Pebble Count/49-point Grid Tosses Residual Pool Depth Measurements WEPP Modeling USFS GRAIP Modeling Macroinvertebrate surveys	MVWQD and others, including UM students	$40 - $60/hour or free
Vegetation	Greenline Assessment Photo Points NRCS Riparian Assessment	MVWQD and others, including UM students	$40-&60/hour or free
Fishery	Inventory fish-passage barriers Monitor WCT genetic composition Assess connectivity with Bitterroot River and wild trout fluvial component	FWP & TU	$50 -$ 60/hour
Education and Outreach	Tracking number of people attending events, receiving educational materials or participating in restoration activities.	MVWQD and others.	$40/hour

Additional information will be collected as needed based on future conditions. Some possible parameters include total suspended solids measurements, surveys of eroding bank areas, width-to-depth ratios, macroinvertebrate studies, and fish population surveys. WEPP road modeling will be used, as appropriate, to estimate expected load reductions from road decommissioning.

Table 12. Criteria for Measuring Progress		
Parameter	*Criteria*	*Timeframe*
Temperature	Reduce high temperature by 1 – 2°F	15 years
Sediment	Reduce sediment loading by 15%	15 years
Vegetation	Increase shade percentage by 10 – 15%	15 years
Fishery	Maintain WCT genetic purity in isolates Expand area of perennial flow in main stem reach Enhance connectivity with Bitterroot River Mitigate fish passage obstructions	15 years
Education and Outreach	>200 people reached Two HOAs participating in revegetation efforts Engaging students from one local school in restoration project	2 years

References Cited

Bair, Brian. 2004. Stream Restoration Cost Estimates. Proceedings of the Salmon Habitat Restoration Cost Workshop. Portland, OR: Pacific States Marine Fisheries Commission. https://www.st.nmfs.noaa.gov/st5/Salmon_Workshop/11_Bair.pdf (Accessed November 16, 2017)

Bitterroot Temperature and Tributary Sediment Total Maximum Daily Loads and Framework Water Quality Improvement Plan. 2011. Helena, MT: Montana Department of Environmental Quality.

Change Authorization, Mountain Water Company Water Rights. 2014. Helena, MT: State of Montana Department of Natural Resources and Conservation (DNRC).

Hewitt, Tobias J. 2004. Characterization of Impacts to Water Resources of Upper Miller Creek from Septic System Effluent, Missoula County, Montana. Master's Thesis. Missoula, MT: University of Montana.

Knotek, Ladd. 2017. Montana Fish, Wildlife and Parks. Email.

Linda Vista Estates 2015 Phasing Plan Amendment. 2015. Missoula, MT: Development Services, City of Missoula.

PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO). (n.d.). Missoula, MT: United States Forest Service, Region 1.

Riparian Assessment: Using the NRCS Riparian Assessment Method. 2012. Environment Technical Note No. MT-2. Natural Resources Conservation Service. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_050752.pdf (Accessed November 30, 2017)

Sugden, Brian and Woods, Scott. 2007. Sediment Production from Forest Roads in Western Montana. Journal of the American Water Resources Association. American Water Resources Association.

Teton Addition 2015 Phasing Plan Amendment. 2015. Missoula, MT: Development Services, City of Missoula.

Appendix A

Miller Creek Survey Results

Q1 - What is most important to you about Miller Creek?

Code	Response Item	Frequency	Percent
1	Scenic	9	16.67%
2	Fish & Wildlife	7	12.96%
3	Irrigation/Agriculture	1	1.85%
4	Other	5	9.26%
5	All of the Above	4	7.41%
6	Scenic, Fish & Wildlife, and Irrigation/Agriculture	3	5.56%
7	Scenic and Fish & Wildlife	13	24.07%
8	Scenic & Irrigation	1	1.85%
9	Scenic & Other	2	3.70%
10	Fish & Wildlife and Irrigation/Agriculture	1	1.85%
11	Fish & Wildlife and Other	3	5.56%
13	Did not Answer	1	1.85%
14	Scenic, Fish & Wildlife, and Other	4	7.41%
	TOTAL	**54**	

Q2 - What issues do you think need to be addressed to maintain and improve the health of the creek and the watershed?

Code	Response Item	Frequency	Percent
1	More streamside vegetation	2	3.77%
2	Opportunities to increase stream flow	7	13.21%
3	Fencing	0	0.00%
4	Culvert replacement	0	0.00%
5	Weed Management	5	9.43%
6	Other	5	9.43%
11	More streamside vegetation and Opportunities to increase stream flow	1	1.89%
14	More streamside vegetation and Weed Management	7	13.21%
15	More streamside vegetation and Other	2	3.77%
19	Opportunities to increase stream flow and Fencing	1	1.89%
21	Opportunities to increase stream flow and Weed Management	2	3.77%

22	Opportunities to increase stream flow and Other	3	5.66%
26	Fencing & Weed Management	1	1.89%
29	Culvert replacement and Weed Management	1	1.89%
31	Weed Management and Other	2	3.77%
32	Not Answered	2	3.77%
35	More steamside vegetation, Fencing, Culvert replacement and Weed management	1	1.89%
37	More streamside vegetation, Weed management and Other	1	1.89%
39	More streamside vegetation, Opportunities to increase stream flow and Weed management	6	11.32%
40	More steamside vegetation, Fencing and Other	2	3.77%
41	More streamside vegetation, Opportunities to increase stream flow, Fencing and Other	1	1.89%
42	More steamside vegetation, Opportunities to increase stream flow, Culvert replacement and Weed management	1	1.89%
	TOTAL	**53**	

Column1	Response Item	Frequency	Percent
	More streamside vegetation	2	3.57%
	Opportunities to increase stream flow	0	0.00%
	Fencing	1	1.79%
	Culvert replacement	0	0.00%
	Weed Management	8	14.29%
	Other	18	32.14%
	More streamside vegetation and Opportunities to increase stream flow	2	3.57%
	More streamside vegetation and Weed Management	4	7.14%
	More streamside vegetation and Other	2	3.57%
	Opportunities to increase stream flow and Weed Management	2	3.57%
	Fencing & Other	1	1.79%
	Culvert replacement and Weed Management	1	1.79%
	Culvert replacement and Other	1	1.79%
	Weed Management and Other	1	1.79%
	Not Answered	7	12.50%
	More steamside vegetation, Fencing, Culvert replacement and Weed management	1	1.79%
	More streamside vegetation, Weed management and Other	1	1.79%
	More streamside vegetation, Opportunities to increase stream flow and Weed management	3	5.36%

	More steamside vegetation, Opportunities to increase stream flow, Culvert replacement and Weed management	1	1.79%
		TOTAL	**56**

Top Values	
Scenic	59.26%
Wildlife	57.41%

Top Issues to be Addressed	
Streamside vegetation	45.28%
Increased stream flow	37.74%
Weed management	50.94%

Top Issues to be Addressed on Property	
Streamside Vegetation	28.57%
Increased Streamflow	14.29%
Weed management	37.50%
Total interested in projects on property	83.05%