Beaverhead Watershed Restoration Plan

December 2013

Table of Contents

LIST OF ACRONYMS

BMI – Barrett Minerals, Inc.
BWC - Beaverhead Watershed Committee
BLM – U.S. Bureau of Land Management
BOR – U.S. Bureau of Reclamation
DEQ – Montana Department of Environmental Quality
DNRC – Montana Department of Natural Resources and Conservation
FWP – Montana Fish, Wildlife & Parks
NRCS – U.S. Natural Resources and Conservation Service
TMDL – Total Maximum Daily Load
USFS – U.S. Forest Service
WRP – Watershed Restoration Plan

EXECUTIVE SUMMARY

Watershed restoration plans help protect and restore water resources by providing a framework for managing efforts to both restore water quality in degraded areas and to protect overall watershed health. As one of the requirements for receiving grants under Section 319 of the federal Clean Water Act, the Beaverhead Watershed Committee (BWC) must provide this comprehensive assessment of the Beaverhead watershed, which is located in southwest Montana. The plan identifies nonpoint source pollution in the watershed, their sources, and effects, and outlines a set of strategies to measure and mitigate each.

Specifically, this plan focuses on those streams that the Montana Department of Environmental Quality (DEQ) lists as impaired, including the Beaverhead River. Because land ownership in the watershed is a mix of federal, state, and private holdings, coordination and collaboration of varied interests are crucial to protecting the water resource. With assistance from DEQ, BWC helps synchronize efforts among local groups and citizens to maintain public awareness about the watershed and continually improve its quality. BWC and partners collaborate to address water quality issues by fully assessing the contributing causes and sources of pollution and setting priorities for restoration and protection.

The plan describes priority projects in five stream reaches, including identifying water-quality issues, offering potential solutions, and describing the roles that stakeholders play. Estimated reductions in sediment loading (a primary impairment issue) are discussed. Actions are defined as short-term (5 years) and long-term (8+ years) priorities, and criteria for monitoring successes are defined. Also described are funding needs, educational projects, and other watershed restoration projects managed by federal and state agencies.

SECTION 1: INTRODUCTION

WHAT IS A WATERSHED RESTORATION PLAN?

Watershed restoration plans (WRPs) are designed to help protect and restore our country's water resources. Creating a plan is one of the requirements for groups receiving grants under Section 319 of the federal Clean Water Act, which is administered by the U.S. Environmental Protection Agency (EPA). In Montana, the Montana Department of Environmental Quality (DEQ) manages the EPA grants. Below we paraphrase EPA in describing WRPs and their components.[1]

Watershed restoration plans provide a framework for managing efforts to both restore water quality in degraded areas and to protect overall watershed health. A WRP is a comprehensive assessment that identifies nonpoint source pollution, its sources, and effects, and outlines a set of strategies to measure and mitigate each.

Because nonpoint pollution arises from many diffuse sources, and mitigating it often requires voluntary action by individual landowners, successfully achieving water quality goals typically involves years of support through a coalition of stakeholders and a variety of programs and funding sources. WRPs help stakeholders holistically address water-quality issues by fully assessing the contributing causes and sources of pollution and setting priorities for restoration and protection.

EPA's Nine Key Elements for WRPs

Although many different components may be included in a WRP, EPA lists nine key elements critical for achieving water quality improvements and that must be included in all WRPs supported with Section 319 funding. The elements are summarized below and are included in this WRP in the noted sections.

1. Identify causes and sources of pollution. (Section 2)
2. Estimate pollutant loading into the watershed and expected load reductions. (Sections 2 & 3, respectively)
3. Describe management measures to achieve load reductions in targeted critical areas. (Section 3)
4. Estimate the required technical and financial assistance and the relevant authorities needed to implement the plan. (Section 4)
5. Develop an information/education component. (Section 4)
6. Develop a project schedule. (Section 5)
7. Describe interim measurable milestones. (Section 6)
8. Identify indicators to measure progress. (Section 6)
9. Develop a monitoring component. (Section 6)

WHO DEVELOPS AND IMPLEMENTS THE PLAN?

In August 2001, the Beaverhead Watershed Committee (BWC) formed with the goal of developing an understanding of the watershed and to create an organized approach for addressing a wide variety of issues and implementing restoration efforts. We coordinate efforts among local groups and citizens to maintain public awareness about the watershed and work toward improving its quality.

[1] A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters: EPA 841-R-13-003.

BWC comprises 14 volunteers representing a diverse group of people who live within the watershed boundary: landowners, outfitters and guides, business owners, Trout Unlimited, Beaverhead County Commissioners, the city of Dillon, and the Beaverhead Conservation District. Committee members have years of observational and technical knowledge about the watershed and changes it has undergone. Since BWC's inception, we have successfully completed a growing roster of conservation projects in cooperation with stakeholders and technical advisors.

In the mid-2000s, BWC began working with DEQ to develop plans for Total Maximum Daily Loads (TMDLs) for the watershed. DEQ is EPA's designated management authority for protecting state waters and has worked with dozens of watershed groups throughout the state to develop and implement both TMDLs and WRPs. BWC's role in this process is to assist DEQ in identifying the causes and sources of watershed problems, work with a coalition of stakeholders to find and implement solutions, and develop a locally-based, locally-driven WRP. We will continue to partner with DEQ, along with other agencies and non-governmental organizations, to implement this WRP.

What is the Goal of the Beaverhead WRP?

BWC's mission is to understand how the watershed functions—how it supports the communities that depend upon it—and to build a partnership among stakeholders with diverse viewpoints in order to achieve the common goal of watershed protection. Thus, restoring and maintaining water quality standards is our top priority. The goal of the WRP is to provide a framework for restoration by implementing recommended TMDLs (see Section 2). This WRP also outlines watershed activities, potential restoration projects by priority, and funding sources and partners; it can be revised to incorporate new information and technological advances related to hydrology and aquatic restoration, monitoring activities, restoration effectiveness, and stakeholder priorities.

How Can I Participate?

BWC welcomes input and participation from landowners, agriculture groups, business owners, outfitters and guides, conservation groups, local and state government entities, and individuals. We seek viable restoration projects and ideas for improving watershed health. We encourage citizens to attend committee meetings and/or to share their ideas for improving the health and quality of the Beaverhead watershed. All meetings are open to the public.

For more information about BWC, our projects, plans, and meeting minutes, visit us online at http://www.beaverheadwatershed.org or email us at beaverheadwatershed@gmail.com.

Section 2: Identifying the Watershed and Its Pollutant Sources and Causes

A Description of the Beaverhead Watershed

The Beaverhead watershed is located in Beaverhead County, Montana, with a small portion in Madison County, and includes the towns of Dillon and Twin Bridges (**Figure 1**). The watershed is bound by the Pioneer Mountains to the west, the Ruby Range to the east, and the Snowcrest Range and Blacktail Mountains to the south.

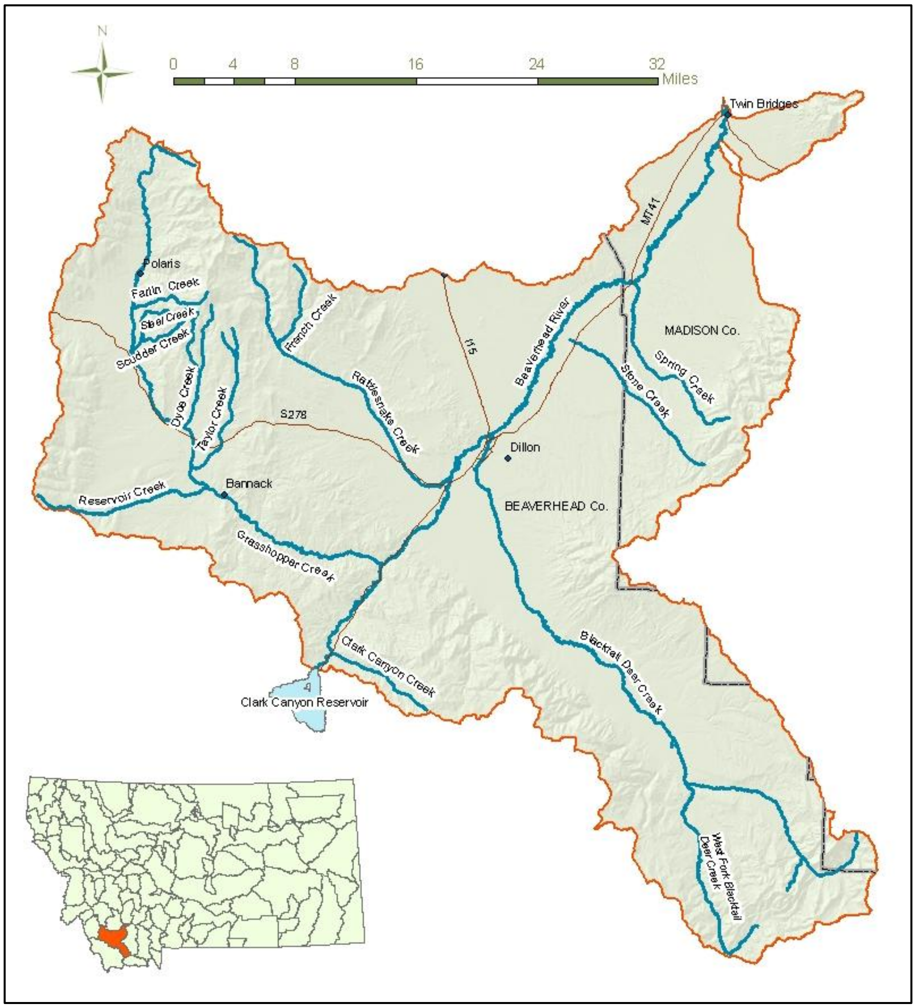

Figure 1. Map of the Beaverhead Watershed and its impaired streams (in blue).

The headwaters of the Beaverhead River begin at the outlet of Clark Canyon Reservoir, which was created in 1964 from Horse Prairie Creek and the Red Rock River. The U.S. Bureau of Reclamation (BOR) built the dam and associated infrastructure for irrigating the bench east of Dillon. Below the dam, the Beaverhead River flows about 15 miles through a canyon before entering the Beaverhead valley. The river continues northeast for about another 64.5 miles before joining the Big Hole River just north of Twin Bridges. At this confluence the two rivers form the Jefferson River.

Major tributaries include Grasshopper Creek, Blacktail Deer Creek, and Rattlesnake Creek. The Ruby River drains into the Beaverhead River slightly more than 1 mile south of Twin Bridges.

Land Ownership

Approximately 39% of the land area is federally owned, 15% is state owned (including lands managed by Fish, Wildlife & Parks), and about 46% is privately owned (Montana Dept. of Environmental Quality, 2012b). Most of the federal lands—U.S. Forest Service (USFS) and Bureau of Land Management (BLM)—fall within higher elevations of the watershed. In general, lower elevations in the Beaverhead valley are private lands, with some BLM and State Trust Lands. BOR manages Clark Canyon Reservoir. **Figure 2** maps the land ownership.

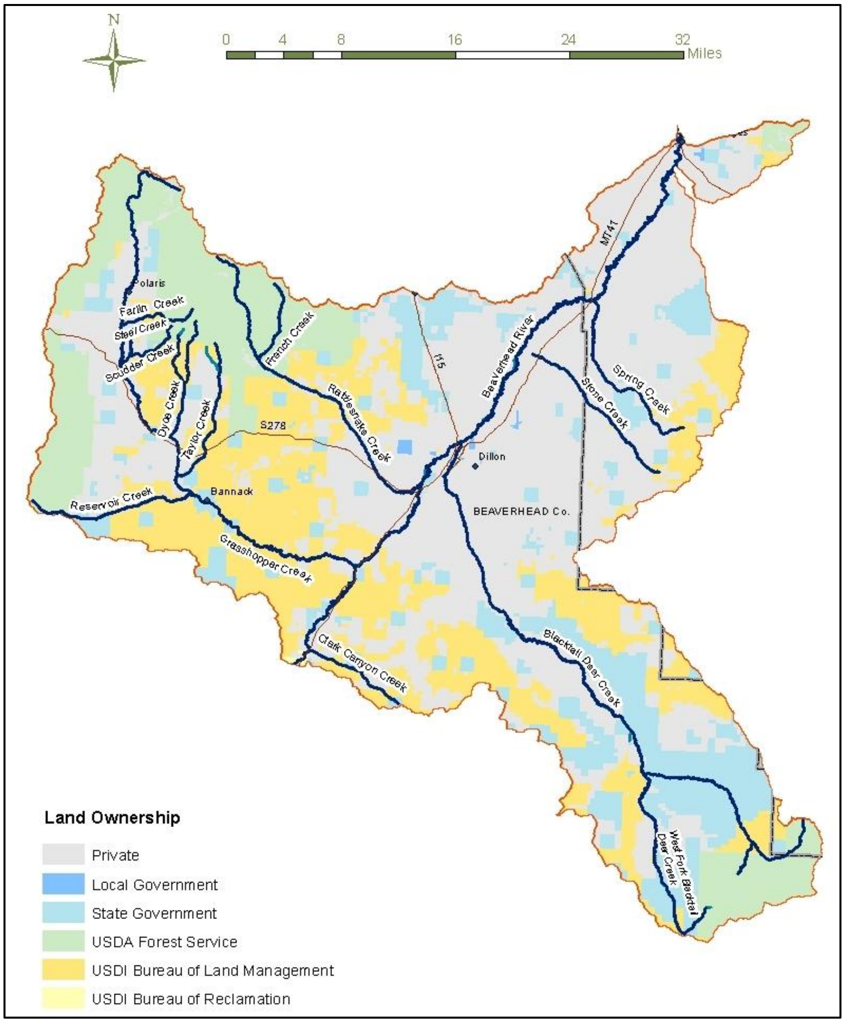

Figure 2. Land Ownership in the Beaverhead Watershed.

Water Flows

BOR's East Bench Unit irrigates 49,800 acres via the diversion dam at Barretts, which is located approximately 14 miles below Clark Canyon Dam (Rogers, 2008). Water levels in Clark Canyon Reservoir influence the flow regime in the Beaverhead River, and peak flows are shifted to later in the summer. Reduced flows are distinct in spring (April/May) and fall (October/November), resulting in an inverted hydrograph (i.e., higher flows during summer and lower flows in fall and spring).

Land Use

Historically, land uses in the watershed included mining, fur trapping, and agricultural operations (primarily ranching). Current land use is primarily agricultural cattle production, with limited grain crops and potato production. A large portion of the upper watershed is used for rangeland. The narrow floodplains of the major tributaries are irrigated for production of hay and alfalfa and for pasture. Irrigation canals installed in the mid- to late-20th century provide irrigation water from the Beaverhead River, much of which is derived from Clark Canyon Reservoir.

Other current land uses in the watershed include recreation, logging, and mining. The most intensive recreation uses are fishing and autumn big game hunting, especially in the upper drainage of Blacktail

Deer Creek. Mining has been, and still is, an important land use and a potential source of impairment to water quality. A large operating talc mine is located in the Stone Creek watershed.

TOTAL MAXIMUM DAILY LOADS

In July 2012, DEQ completed a Total Maximum Daily Load (TMDL) for sediment in the Beaverhead watershed. A temperature TMDL for the mainstem Beaverhead River is expected to be completed in spring 2014. The TMDLs identify the causes and sources of pollution and establish allowable loads that meet Montana's water quality standards. The TMDLs also describe general management measures and restoration activities that can improve water quality.

Throughout the TMDL process, BWC assisted DEQ by identifying stakeholders and coordinating public meetings. To complete the Beaverhead sediment TMDL, BWC coordinated with

- Beaverhead Conservation District
- Montana Fish, Wildlife & Parks
- Bureau of Reclamation
- U.S. Forest Service
- U.S. Natural Resources Conservation Service
- Bureau of Land Management
- Montana Department of Natural Resources
- Clark Canyon Reservoir Joint Board
- Local landowners and businesses (e.g., outfitters and guides)

THE BEAVERHEAD'S IMPAIRED WATERS

The streams listed in **Table 1** are on DEQ's list of impaired waters for sediment, nutrients, metals, temperature, or other types of pollution. Because only sediment and temperature TMDLs have been developed, or are under development as of 2013, this WRP focuses primarily on streams with sediment and/or temperature listings. However, many of the recommended best management practices and proposed restoration activities discussed in this WRP can positively affect several different types of impairments. See **Figure 1** for a map of the impaired waters.

Table 1. Waterbodies in the Beaverhead watershed with listed impairments on Montana DEQ's list of impaired waters (Montana Dept. of Environmental Quality, 2012a).

Waterbody	Listed Causes of Impairment
Beaverhead – Clark Canyon to Grasshopper	Low-flow alterations, alteration in streamside vegetative covers, lead
Beaverhead – Grasshopper to mouth	sediment, temperature, low-flow alterations, alteration in streamside vegetative covers, habitat alterations
Blacktail Deer Creek	sediment, temperature, low-flow alterations, alteration in streamside vegetative covers
Clark Canyon Creek	sediment, total phosphorus, alteration in streamside vegetative covers
Dyce Creek	sediment, total nitrogen, low-flow alterations, alteration in streamside vegetative covers

Farlin Creek	sediment, alteration in streamside vegetative covers
French Creek	sediment, alteration in streamside vegetative covers
Grasshopper Creek	sediment, low-flow alterations
Rattlesnake Creek, lower segment	sediment, total nitrogen, total phosphorus, low-flow alterations, metals (cadmium, copper, lead)
Rattlesnake Creek, upper segment	sediment, total nitrogen, total phosphorus, alteration in streamside vegetative covers, metals (cadmium, copper, lead)
Reservoir Creek	sediment, total nitrogen, total phosphorus, alteration in streamside vegetative covers
Scudder Creek	sediment, total nitrogen, alteration in streamside vegetative covers
Spring Creek	sediment, total nitrogen, low-flow alterations, chlorophyll-*a*, arsenic, alteration in streamside vegetative covers
Steel Creek	sediment, total nitrogen, total phosphorus, alteration in streamside vegetative covers, arsenic
Stone Creek, lower segment	sediment, nitrates, total phosphorus, alteration in streamside vegetative covers, arsenic, chlorophyll-*a*
Stone Creek, upper segment	sediment, nitrates, low-flow alterations, alteration in streamside vegetative covers, turbidity
Taylor Creek	sediment, total nitrogen, alteration in streamside vegetative covers
West Fork Blacktail Deer Creek	sediment, alteration in streamside vegetative covers, arsenic, chlorophyll-*a*
West Fork Dyce Creek	sediment, total nitrogen, alteration in streamside vegetative covers, manganese

SEDIMENT CAUSES AND SOURCES

The sediment TMDL identified roads, bank erosion, upland erosion, and lack of riparian buffering as major causes of sediment loading in the watershed. These are known as nonpoint sources because they come from many different sources over a diffuse area; point sources of pollution (i.e., those that have a specifically identifiable point of entry into the watershed) are managed through permits and are not addressed in this plan. For each of these causes, primary sources were identified and best management practices were recommended (**Table 2**).

Unpaved Roads

Unpaved roads contribute 66 tons of sediment annually to the Beaverhead Watershed (Montana Dept. of Environmental Quality, 2012b). This includes 45 tons annually from unpaved road crossings and 21 tons annually from unpaved road segments that run parallel to streams. For streams, sediment loads range from < 1 ton/year for Clark Canyon Creek to 19 tons/year for the Beaverhead River. These roads are located on both federal and private lands.

Upland Erosion

Upland erosion contributes approximately 17,952 tons annually to the Beaverhead watershed (Montana Dept. of Environmental Quality, 2012b). The assessment indicates that rangeland grazing and hay production within the near-stream riparian buffer are the most significant contributors to accelerated upland erosion. Sediment loads from upland erosion range from 61 tons/year in the Steel Creek sub-watershed to 3,846 tons/year in the lower Beaverhead River sub-watershed.

Streambank Erosion

Streambank erosion contributes an estimated 68,525 tons of sediment annually to the Beaverhead watershed; of this, 82% is attributable to human sources (Montana Dept. of Environmental Quality, 2012b). DEQ has estimated that this sediment load can be reduced by 69% (approximately 21,122 tons annually) by encouraging landowners and other land management agencies to implement BMPs. Sediment loads from streambank erosion range from 396 tons/year in West Fork Dyce Creek to 27,505 tons per year in the lower Beaverhead River. Current riparian grazing and past uses (including clearing, mining, and grazing) combine to make up the greatest human-caused contributors of sediment loads from streambank erosion for most of the assessed sites in the watershed. Irrigation and hay production in Stone Creek and hay production in Blacktail Deer Creek are the major contributing sources of streambank erosion in those streams but are not primary sources throughout the watershed.

Temperature Causes and Sources

The primary causes and sources of temperature impairment for the listed streams, the Beaverhead River (upper and lower segments) and Blacktail Deer Creek, are decreased flows from water diversions and loss of riparian habitat, the latter of which provides shade and appropriate channel width-to-depth ratios that help keep waters cool. DEQ is currently developing the temperature TMDL, and more details on temperature causes and sources will be included in the next revision of this WRP.

Section 3: Identifying Best Management Practices and Expected Reductions

Estimated Reductions in Sediment Loading

The sediment TMDL estimates the amount of sediment that could be reduced by implementing appropriate best management practices (BMPs). **Table 2** lists the estimated sediment load reductions for each waterbody in both tons/year and by percent reduction from current estimated loads. **Note:** The methods and models used to calculate loads and expected load reductions are estimates only.

Table 2. Estimate of sediment load reductions (tons/yr) expected by implementing BMPs by source category and total for streams with sediment TMDLs (Montana Dept. of Environmental Quality, 2012b). The percent reduction from the current estimated load is shown in parentheses.

Waterbody	Roads	Bank Erosion	Upland Erosion	Total*
Beaverhead Watershed (TMDL Planning Area)	**47 (70%)**	**47,403 (69%)**	**12,411 (69%)**	**59,788 (69%)**
Beaverhead, lower	13 (68%)	21,114 (77%)	2,795 (73%)	23,922 (76%)
Blacktail Deer Creek	13 (72%)	5,196 (61%)	4,460 (69%)	9,688 (64%)
Clark Canyon Creek	0.2 (67%)	674(62%)	55 (38%)	730 (59%)
Dyce Creek	1.4 (74%)	917 (61%)	173 (69%)	1,091 (62%)
Farlin Creek	0.3 (75%)	412 (56%)	58 (62%)	470 (57%)
French Creek	1.2 (73%)	570 (67%)	128 (58%)	700 (65%)

Grasshopper Creek	11.9 (72%)	8,324 (62%)	2,623 (68%)	10,959 (63%)
Rattlesnake Creek, lower segment	5.1 (70%)	2,574 (57%)	973 (65%)	3,554 (59%)
Rattlesnake Creek, upper segment	2.7 (73%)	1,919 (54%)	421 (59%)	2,344 (55%)
Reservoir Creek	0.3 (67%)	1,660 (64%)	81 (70%)	1,742 (64%)
Scudder Creek	0.8 (69%)	702 (59%)	116(71%)	819 (60%)
Spring Creek	1.8 (70%)	2,894 (72%)	521 (68%)	3,417 (71%)
Steel Creek	0.5 (66%)	257 (62%)	76 (74%)	334 (64%)
Stone Creek, lower	1.3 (66%)	3,217 (75%)	687 (74%)	3,905 (74%)
Stone Creek, upper	1.1 (66%)	2,193 (75%)	534 (75%)	2,728 (74%)
Taylor Creek	0.8 (74%)	1,324 (58%)	257 (75%)	1,582 (60%)
West Fork Blacktail Deer Creek	2.4 (77%)	946 (55%)	908 (75%)	1,856 (63%)
West Fork Dyce Creek	0.4 (70%)	248 (63%)	63 (71%)	312 (64%)
* The Total sum may not add up correctly because of rounding individual source estimates.				

Recommended Best Management Practices for Sediment Reduction

Table 3 lists several BMPs that could be implemented to reduce sediment loading for each identified cause.

Table 3. Causes, human-caused sources, and recommended BMPs for sediment loads identified in the Beaverhead Sediment TMDL (Montana Dept. of Environmental Quality, 2012b).		
Sediment Cause	**Source**	**Recommended BMPs**
Roads	• Unpaved roads • Road crossings • Traction sand application • Culvert failure	• Reduce contributing lengths of road and parallel segment lengths to 100 feet maximum. • Install crossing BMPs (hardened crossings, silt fences, settling basins, etc.). • Install water bars. • Re-contour roads to deflect sediment-laden runoff from the stream. • Maximize efficiency of traction sand during winter months. • Repair or replace undersized or failing culverts.
Bank erosion	• Riparian grazing • Cropland • Mining • Silviculture • Irrigation (altered-flow fluctuations)	• Install off-site livestock watering with shade structures. • Limit livestock access to streams (grazing management plans, fencing, etc.). • Install water gaps or hardened crossings for livestock access to stream. • Establish woody riparian vegetation along streambanks. • Establish riparian buffers or vegetated filter strips along stream corridors. • Manage "flushing flows" for irrigation-controlled waterways (Allied Engineering, 2013).
Upland erosion and riparian buffering	• Forestry, grazing, crop production • Streamside vegetation removal • Development/construction	• Establish riparian buffers or vegetated filter strips along stream corridors. • Implement forestry BMPs, including the Streamside Management Zone, for timber, road, restoration, etc., projects (see Logan, 2001). • Implement conservation tillage, crop rotation, strip cropping, etc., to reduce soil erosion. • Maintain upland vegetation cover through grazing management. Establish woody riparian vegetation along streambanks. • Protect waterways during construction with retaining walls, mulches, earth dikes, sediment traps/basins, and other methods.
Point sources	• Dillon Wastewater Treatment Facility • Beaverhead Talc Mine • Barretts Minerals, Inc. • Concentrated animal feeding operations (CAFOs) • Construction stormwater permits	• Carefully manage and enforce all permitted activities.

Estimated Reductions in Temperature

The temperature TMDL, due in spring 2014, will estimate the reductions in temperature impairments. These will be included in the next revision of this WRP.

Recommended Best Management Practices for Temperature Problems

Many sediment BMPs identified in **Table 3** associated with bank erosion and riparian buffering, including grazing management plans and practices that limit cattle access to the stream (e.g., riparian fencing, offsite watering, or water gaps), will also benefit water temperature by improving riparian habitat and creating shade. Decreased flows and flow alterations may be improved with improvements to irrigation efficiency or changes in irrigation systems that reduce warmwater returns to the Beaverhead River. However, depending on site-specific conditions, changes in irrigation systems may have unintended consequences for groundwater recharge and late-season streamflows. Such potential effects should be assessed on a site-by-site basis before irrigation system changes are implemented.

Section 4: Identifying Technical & Financial Assistance, Developing an Information & Education Component

Technical Partners and Financial Assistance

The Beaverhead Watershed Committee's Watershed Advisory Group comprises a diverse membership of 14 volunteers with a broad representation of groups. We rely on their knowledge and expertise to guide our activities and priorities:

- Agricultural Community
  - Beaverhead – Upper, Middle, Lower
  - Red Rock/Horse Prairie Creek
  - Grasshopper Creek
  - Blacktail Deer Creek
- Outfitters and Guides
- Local Businesses
- Trout Unlimited
- Beaverhead County Commissioners
- City of Dillon
- Beaverhead Conservation District

Several members sit on boards of various water management authorities in southwest Montana:

- East Bench Irrigation District
- Clark Canyon Water Supply
- Red Rock/Lima Dam

BWC relies on many technical partners (too many to list here) for input on project development, implementation, and monitoring. Some of our main partners include:

- Montana Department of Environmental Quality
- U.S. Natural Resources Conservation Service
- U.S. Bureau of Land Management
- U.S. Forest Service
- Montana Fish, Wildlife & Parks
- Montana Dept. of Natural Resources & Conservation
- U.S. Bureau of Reclamation
- Joint Board/East Bench Irrigation District
- Beaverhead County
- City of Dillon
- Beaverhead County Extension
- Various consulting firms

Financial assistance for projects and operations is critical to the continued success of BWC efforts. We recognize there are various sources of financial assistance and the need to diversify our funding sources. We rely on grants, in-kind services, and donations to fund projects and their coordination and administration. A table provided by the Montana Watershed Coordination Council outlines various sources for funding water quality projects and can be found online at: www.mtwatersheds.org/Documents/Resources/Natural_Resource_Grant_Program_Spreadsheet_2012_1.pdf

Information and Education

BWC is planning several information and education activities:

1. Hold monthly meetings, open to the public, and featuring experts discussing watershed-related topics and addressing any concerns citizens might have.
2. Develop and host workshops for conservation district supervisors, local contractors, landowners, and others according to educational needs. A workshop on the various techniques for successfully revegetating and bioengineering streambanks is planned for spring 2014 and will target conservation district supervisors and local contractors. Other workshop topics may include agricultural or 310-permit BMPs.
3. Participate annually in the Beaverhead County Fair to better advertise projects and promote watershed activities to the public.
4. Participate annually in the Parkview Elementary Outdoor School for fifth-graders. In this forum we can reach approximately 80 fifth-graders to teach them about watersheds, water quality, and soil erosion through hands-on learning (e.g., DRNC's Rolling Rivers Trailer).
5. Participate in local civic meetings as needed. Continue to develop relationships with various groups by presenting at meetings and discussing partnership opportunities.
6. Produce and distribute an annual newsletter/report to highlight BWC's projects and activities.
7. Improve BWC's website to attract more interest in the committee and its efforts, making the website more user-friendly and easier to learn about BWC.
8. Conduct tours of completed projects.

SECTION 5: IDENTIFYING AND IMPLEMENTING RESTORATION PROJECTS

THE 5-YEAR RESTORATION PLAN

For the 5-year restoration plan, BWC and technical partners chose four priority areas based on past priority areas, the feasibility of completing the work, landowner/partner participation, and the amount of potential reductions in sediment loading. The projects are divided by sub-watershed and the four areas are Clark Canyon Creek, Lower Spring Creek, Stone Creek (Upper and Lower), and Dyce Creek (**Figure 3**).

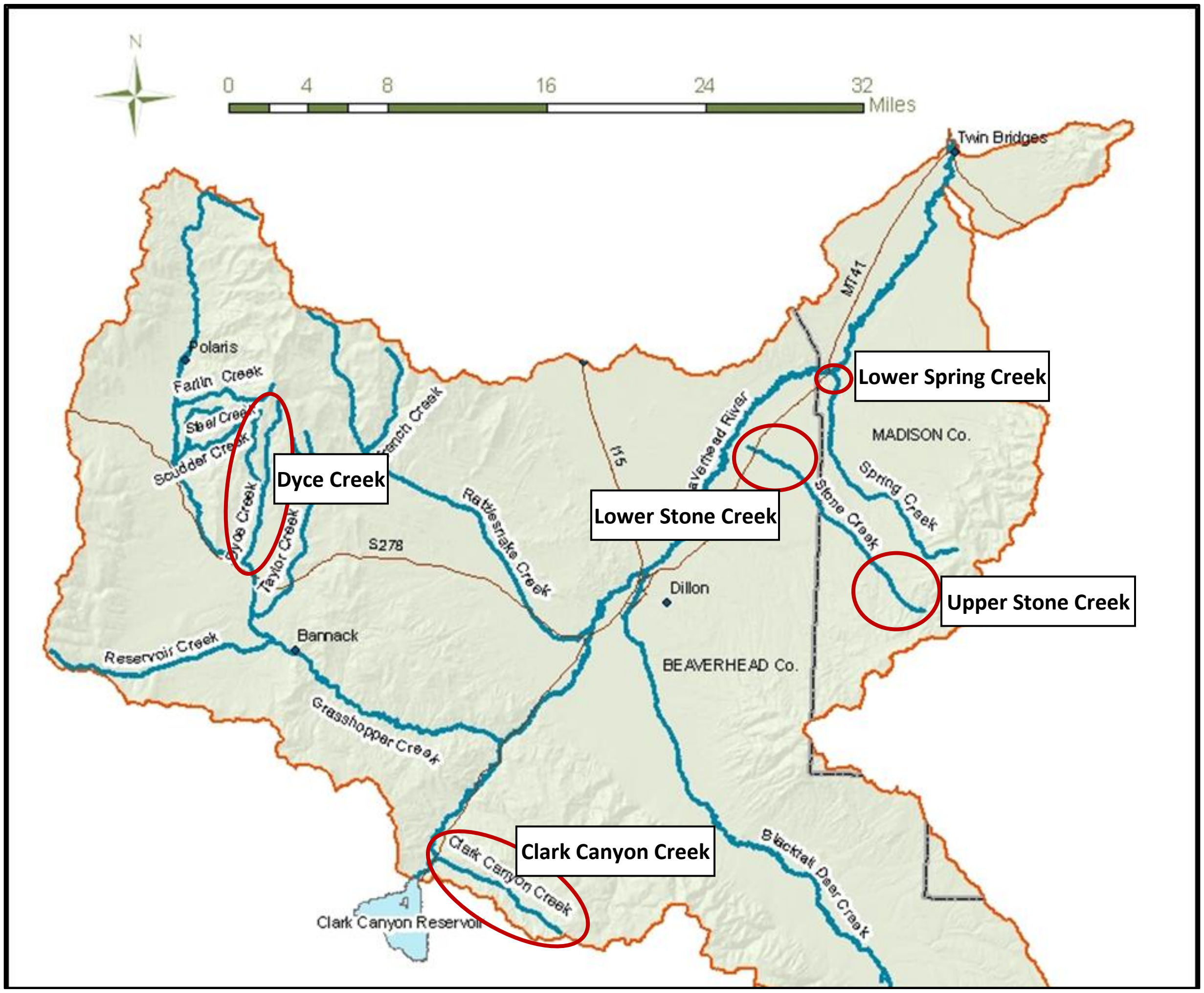

Figure 3. Priority streams for the Beaverhead Watershed Committee's 5-year restoration plan are circled.

Table 4 outlines the basic project description, parties involved, a timeline, and anticipated costs for each. A more detailed summary of each project site is provided below.

Table 4. Beaverhead Watershed project plan list.

Location	Project	Description	Who	When	Resources Required	BWC Role	Possible Funding Source
Clark Canyon Creek	Clark Canyon Creek	Reduce sediment from entering the Beaverhead River. Large sediment events in conjunction with low flows in the Beaverhead River have a detrimental effect on water quality in the upper reach.	BWC, FWP, Landowner	Summer 2013	$100,000-$300,000	Lead	DNRC RRG, DEQ 319, FWP Future Fisheries, Landowner
		Task 1. Site Reconnaissance		Fall 2013			
		Task 2. Fundraise		Ongoing			
		Task 3. Final Design		Fall 2014			
		Task 4. Construction		Fall 2014			
Spring Creek	Lower Spring Creek	Reduce sediment to the Beaverhead River and improve streambank habitat in the lower reach of Spring Creek.	BWC, Landowner	Summer 2014	$120,000	Lead	DEQ 319, NRCS, Landowner
		Task 1. Conceptual Design		Summer 2013			
		Task 2. Fundraise		Ongoing			
		Task 3. Final Design		Fall 2014			
		Task 4. Construction		Winter 2015			
Stone Creek	Upper Stone Cr., Road Improvements	Reduce sediment by improving road grading on approximately 1 mile reach.	BWC, Beaverhead County, BMI	Summer 2015	$50,000	Co-leader	Beaverhead County, BMI, DEQ 319, FWP Future Fisheries
	Upper Stone Cr., Grazing Management Plans and Improvements	Work with landowners to improve grazing management and reduce sediment inputs. This includes riparian fencing, hardened crossings, and off-stream water access.	BWC, Landowners	Summer 2015	Project-specific, costs not yet determined	Lead	DEQ 319, FWP Future Fisheries, NRCS, Landowner
	Lower Stone Cr., Nitrate Filtration Phase 2	A wetland impoundment of approximately 2 acres will be constructed on Lower Stone Creek. Environmental benefit is reduction of up to 5 tons annually of nutrient deposition into the Beaverhead River.	BWC, Landowner	Summer 2014	$160,000	Lead	DEQ 319, Landowner, Ducks Unlimited
Dyce Creek	Culvert Crossing	Improve undersized and failing culverts to reduce sediment.	BLM, BWC, FWP, Landowner	Summer 2016	$50,000	Supporter	BLM, DEQ 319, FWP Future Fisheries
	Grazing Management	Working with BLM and Lessee to improve grazing management, including riparian fencing, hardened crossings, and off-stream water access.	BLM	Ongoing	Project specific, costs not yet determined	Supporter	BLM, Lessee
	Road	Grading the roads to reduce sediment.	BLM	Summer 2017	Costs not yet determined	Supporter	BLM, USFS, FWP Future Fisheries

Clark Canyon Creek

Clark Canyon Creek is the first major tributary to the Beaverhead River downstream of Clark Canyon Reservoir. Clark Canyon Creek enters a robust tailwater fishery; the Beaverhead River typically supports 2,000 to 3,000 trout per mile in this reach and provides one of Montana's premier trophy fisheries. Around 40,000 angler days and $5.9 million are spent on the Beaverhead River each year, making the viability of this fishery of high importance both locally and statewide.

The Problem

Periodic high sediment loading from Clark Canyon Creek has severely affected this fishery. Sediment events are stochastic (i.e., they have a random probability) and frequently result from weather events, such as rain-on-snow or severe localized thunderstorms. Conversely, average weather conditions typically do not produce harmful sediment loading. The problem is most pronounced when sediment is delivered quickly from Clark Canyon Creek at the same time as low-flow releases from Clark Canyon Reservoir and when sediment loads from the creek exceed the Beaverhead River's capacity to transport them. These sediment events create extensive deposits of fine sediment along several miles of river, resulting in a severe decline in fish abundance (**Figure 2**).

Figure 2. Sediment event from Clark Canyon Creek, 2010. Clark Canyon Creek flows into the Beaverhead on the upper left side of this photo. Note the clearer water on the far bank compared with the sediment-laden water and debris (near bank) from Clark Canyon Creek.

The abundance of trout is typically reduced by more than 50% following large sediment events, which have occurred more frequently in recent years. Numerous citizens, angling groups, and outfitters have expressed concern and approached BWC about finding a solution. Given the local and statewide economic benefits of preserving this fishery, reducing fine sediment deposition from Clark Canyon Creek is BWC's highest watershed priority.

Recommended Solutions

In 2013, Allied Engineering Services (2013) completed a preliminary engineering–technical feasibility study on the Clark Canyon Creek drainage. Their study concluded that sediment production is primarily from the East Fork Clark Canyon Creek (referred to as the North Fork in the sediment TMDL document), and is most likely the result of natural conditions with minimal input from anthropogenic influences. The TMDL document (DEQ, 2012b) also notes that the upland areas in this drainage are naturally highly erodible and subject to mass failure and erosion; however, historical land management has contributed to exposed banks and removal of riparian habitat.

The Allied Engineering report evaluated five possible ways to reduce or manage sediment loading:

Alternative 1 – Build Storage/Settling Pond. Water can be stored in a single pond located on the East Fork Clark Canyon Creek near the confluence with the mainstem, and/or with a series of terrace ponds located along the East Fork or by using one of several ephemeral drainages located north of Clark Canyon Creek.

Alternative 2 – Introduce Water Spreading. Flatter areas in the watershed could be used to distribute water in a sheet flow. Sediment would drop out in these low-sloping areas as the sheet flow traveled over the landscape. The estimated runoff volumes indicate that fields available for water spreading are too small to handle the large events occurring in the basin. This alternative was not considered further.

Alternative 3 – Create Flushing Flows on the Beaverhead River. High flows in the Beaverhead River that coincide with high sediment runoff from Clark Canyon Creek have the potential to cost-effectively reduce sediment issues. While an attractive solution from many environmental and cost perspectives, implementing flushing flows may be unfeasible given timing considerations and agricultural water needs. As such, this alternative was not discussed further in the report; however, it is discussed below under Other Priority and Project Areas.

Alternative 4 – Modify Existing Irrigation Practices. Existing diversion sites on Clark Canyon Creek would be retrofitted to divert sediment-laden streamflows to irrigated fields, where it would be spread and stored with low berms. Because of the required maintenance and possible damage to diversion structures, this alternative was discarded.

Alternative 5 – Build Check Dams. Small obstructions would be placed across a drainage channel to lower the speed of flows and to capture sediment runoff. Check dams would not provide a viable option for storing or settling fine-grained sediment because of the steepness of sub-basin terrain. However, check dams may be useful for stabilizing eroding gullies. More extensive site reconnaissance is necessary to determine whether gully erosion is a significant source of sediment.

Alternative 1 was the only recommendation selected for further consideration in the technical report. A conceptual model of the pond was drawn to evaluate the effectiveness of different characteristics and the costs. Based on the analysis, Allied Engineering recommended the following:

1. Collect samples of the sediment deposits in the Beaverhead River and analyze their composition.
2. Further evaluate the settling pond alternative. A minimum sediment storage volume of 19 acre-feet is recommended and would store the sediment from the estimated 20% exceedance probability annual peak flow. A maximum storage volume of about 49 acre-feet is

recommended and would store the sediment from the estimated 4% exceedance probability annual peak flow.

3. Build a single sediment pond and monitor it before the alternative is fully implemented. This would provide better understanding of the scale and type of problem sediment.
4. Thoroughly investigate the site to evaluate the check-dam alternative and to evaluate the degree of gully erosion as a potential significant source of sediment.
5. Seek funds for detailed analysis and design.

Based on these recommendations and landowner input, BWC is moving forward with Alternative 1, the settling pond. At this time, the landowner does not want a test pond and would rather build a full-size settling pond. We are working with the landowner to determine how the pond would be maintained and what it would look like in dry times of the year. We also recognize that storing water in a pond might increase water temperatures; however, using a water-control structure that releases water from the bottom of the pond would help mitigate the warming effect. Once the preliminary planning is completed, a site will be selected, and BWC will seek funding for project design.

Lower Spring Creek

Spring Creek is located in Madison County on the lower end (mouth) of the watershed. Per landowner request, at this time BWC is focusing only on water-quality improvements on the lower 0.5-mile reach, from East Bench Road to the Beaverhead River. This lower reach has the potential to provide coldwater refuge and spawning habitat to fish in the Beaverhead River.

The Problem

Spring Creek appears on DEQ's list of impaired streams for sediment, temperature, and nutrients. Current grazing practices are the primary cause of water-quality issues.

Recommended Solutions

In order to improve water quality, the reach will need

- water gaps for cattle to access the stream (**Figure 3**)
- streambank and riparian restoration to reduce sediment delivery and improve fish habitat (**Figure 4**)
- floodplain access for the stream channel to prevent further head-cutting and decrease sediment to the Beaverhead River (**Figure 4**)
- improved irrigation control structures to better manage irrigation demands and allow for fish passage (**Figure 3**)
- livestock corrals at an off-stream site and a new stock watering system (**Figures 5** and **6**)
- replace a perched culvert with a new bridge to allow better fish passage (**Figure 7**)
- riparian fencing to manage grazing effects on the stream (**Figure 4**)

Figure 3. Lower Spring Creek. Start of the lower 0.5-mile reach just below East Bench Road. Cattle access has over-widened the channel, causing sediment deposition. The irrigation control structure is blocking the stream from fish passage. (Photo, August 2013)

Figure 4. Lower Spring Creek. Channel banks are eroding from lack of vegetation. Riparian fencing is needed to prevent cattle access to the stream. (Photo, November 2012)

Figures 5 and 6. Lower Spring Creek. Corrals must be relocated to an off-stream site, and a new stock watering system is needed. (Photos, November 2012)

Figure 7. Lower Spring Creek. A new bridge is needed to replace the perched culvert to reduce sediment delivery and allow better fish passage. (Photo, November 2012)

Upper Stone Creek

Upper Stone Creek originates in the Ruby Mountains and flows from the confluence of the north and middle forks to the confluence of an unnamed tributary. The upper reach contains a population of genetically pure westslope cutthroat trout.

The Problem

Upper Stone Creek appears on DEQ's list of impaired streams for sediment, temperature, and nutrients. The upper reach parallels a main service road for Barrett Minerals' talc mine. In the past, Barrett Minerals has taken steps to improve the road by grading its slope away from the stream channel and installing sediment traps along the roadway. These actions have significantly improved water quality; however, regular maintenance of the road and sediment traps, along with additional road improvements, will be necessary to further reduce sediment delivery to the stream.

Livestock and current grazing practices are another cause of water-quality issues for Upper Stone Creek. Efforts have been made to improve Stone Creek's riparian function and aquatic habitat while reducing the amount of sediment to the Beaverhead River. Restoration projects have included reconstructing the stream channel and bank, revegetating the bank, and fencing the riparian area. The past restoration projects have been successful in reducing sediment inputs; however, additional improvements should be made to further improve water quality.

Recommended Solutions

BWC identified the following projects:

1. Improve the road grade and install additional sediment traps (**Figure 8**).
2. Work with Beaverhead County and Barrett Minerals to develop a maintenance schedule for cleaning out the sediment traps and re-grading the road.
3. Work with private landowners on grazing management. Install riparian fencing and water gaps (**Figures 9** and **10**).

Figure 8. Upper Stone Creek. A storm event erodes the roadway into Stone Creek. (Photo, June 2013)

Figure 9. Upper Stone Creek. A water gap is needed to prevent further erosion. (Photo, June 2013)

Figure 10. Upper Stone Creek. Riparian fencing is needed to improve riparian vegetation and stabilize bank erosion. (Photo, June 2013)

Lower Stone Creek

Summer flow in Lower Stone Creek is generated primarily from groundwater return flows. In most years, the upper reach is disconnected from the lower reach during the summer. Lower Stone Creek flows through lands primarily used for cropping rather than grazing.

The Problem

In 2003, extremely high concentrations of nitrates and nitrites were found in Stone Creek. Their source, although not specifically defined, is likely related in part to years of nitrate-based fertilizer use in the Stone Creek watershed, and possibly from nutrient-laden seepage water entering Lower Stone Creek from the East Bench irrigation ditch. When combined with the high late-summer water temperatures of this slow-moving reach, the nitrates and nitrites can result in excessive algae growth, which can harm fish and other aquatic life.

Recommended Solutions

To demonstrate the potential benefit of natural methods to reduce nutrients, a two-phase pilot program was initiated in 2004 and 2005. During the first phase, Kirk Engineering & Natural Resources conducted a bench-scale test on the Malesich Ranch to determine whether a test wetland was sufficient to treat a small portion of the flow from Lower Stone Creek (Kirk Engineering, 2006).

In 2005, a small (800 ft^2) pilot wetland was built, lined, and planted with local cattails and sedges in order to treat a split stream from Lower Stone Creek. Monitoring included collecting and testing samples of the inflow and effluent of the pond for nitrate content. Water samples from drain tiles in the Lower Stone Creek area below the project site were also collected and analyzed.

Results of this small-scale test wetland confirmed that nitrates could be significantly reduced through constructed wetland filtering. It was estimated that a full-scale 4-acre wetland system (phase 2) could remove approximately 9,000 pounds of nitrates per year, which are currently being delivered to the river. This accounts for more than 20% of the total nitrates delivered to Lower Stone Creek in a typical year. The cost estimate in 2006 to construct the 4-acre wetland was $145,000. BWC is currently seeking funding for phase 2 of this project.

Other BMPs to reduce nitrates being lost to surface and groundwater in the Stone Creek watershed may include (a) developing nutrient management plans, (b) planting cover crops or vegetated filter strips to intercept excess soil nutrients, and/or (c) using precision agriculture tools to best match plant nutrient uptake with fertilizer applications.

Dyce Creek

Although the headwaters of Dyce Creek originate on USFS lands, the Dyce Creek drainage area is located primarily on BLM lands and private property. Upper Dyce Creek splits into east and west forks that are entirely on BLM lands. Montana FWP has identified East Fork Dyce Creek as a priority westslope cutthroat habitat area. In 2011, BLM completed an assessment of the resources in the East Grasshopper watershed, which includes East Fork and West Fork Dyce Creek. In 2012, an Environmental Assessment was completed, which analyzed proposed actions for addressing any identified concerns. These documents are available at http://www.blm.gov/mt/st/en/fo/dillon_field_office/eastgrasshopper.html.

The Problem

BLM found the primary resource concerns to be

- over-widening and streambank trampling
- soil compaction at springs
- undersized and damaged culverts
- juniper encroachment
- conifer expansion into sagebrush/grassland and mountain mahogany stands

Recommended Solutions

BLM's interdisciplinary team recommends the following:

- Reducing the length of time livestock has access to stream reaches.
- Enlarging livestock exclusion areas.
- Building water bars, drain dips, and silt fences or rerouting the road.
- Replacing culverts or constructing hardened crossings.
- Removing or thinning juniper stands.
- Treating invasive plant species with prescribed fire or using other methods to reduce them.

The decision that identified the selected alternative is available, upon request, from the Dillon Field Office. See Appendex A for a BLM map of their project locations.

To reduce sediment delivery in East Fork Dyce Creek, BLM and FWP have identified an undersized and collapsing culvert as a priority project. Replacing the culvert will reduce sediment entering the creek and improve westslope cutthroat habitat. BLM would like to obtain a public road easement through private land on East Fork Dyce Creek Road; if achieved, BLM would improve the stream crossing with an oversized culvert set below grade of the streambed and install water bars above the stream crossing. These improvements would divert sediment originating from road runoff; in addition, other road maintenance issues could be addressed. BWC has identified this as a high-priority project and will assist BLM, FWP, and the private landowner to fix the problem culvert.

Other projects in the area will be evaluated, and BWC will provide assistance as needed. These projects include

- Hardening a stream crossing on East Fork Dyce Creek, using a soil stabilization system (e.g., GeoWeb), and installing water bars on the approaches to divert sediment away from the stream.
- Closing a 0.4-mile section of East Fork Dyce Creek Road on the east side of the drainage to motor vehicles. This would reduce sedimentation issues in high-value westslope cutthroat habitat.
- Removing conifers from the riparian area and adjacent upland areas, along with up to 2.5 miles of the Dyce Creek drainage, within the Baldy Mountain allotment (Dyce Creek Riparian treatment unit).

In addition, the following structural projects will be implemented to improve livestock distribution and provide off-site watering locations, which will help reduce livestock-related effects:

- Construct about 3 miles of three-strand fence along the ridge between East Fork and West Fork Dyce Creek.
- Construct an exclosure at the spring and ponds, and coordinate with the private landowners to install a headbox and water troughs.

- Expand the exclosures at Dyce Creek, El Ante, El Venado, and La Gallina Springs and replace the existing water troughs with 1,000-gallon water troughs at each location. Relocate the replacement troughs at El Ante and La Gallina away from the wetlands.
- If feasible, reconstruct the Red Mine pipeline.
- Develop the springs and install a 1,000-gallon water trough.
- Initiate stream channel restoration on approximately 50 feet of East Fork Dyce Creek, where past stream excavation has greatly over-widened the stream channel and is contributing sediment.
- Construct a riparian exclosure along approximately 0.75 mile of East Fork Dyce Creek to improve riparian function and improve westslope cutthroat habitat.
- Construct up to three additional riparian exclosures if, after one grazing cycle (3 years), measurable progress isn't being made along specific riparian reaches in the Dyce Creek pastures.

OTHER PRIORITY AREAS AND PROJECTS

Listed by partner, the following is a summary of current and future priority projects in the Beaverhead watershed.

Bureau of Land Management (BLM)

BLM is currently working on updating and implementing Environmental Assessments throughout the Beaverhead Watershed; BWC will assist with projects as needed. A completed list of the BLM Dillon Field Office's Watershed Assessments and Environmental Assessments can be found at http://www.blm.gov/mt/st/en/fo/dillon_field_office.html.

U.S. Forest Service (USFS)

The Beaverhead–Deerlodge National Forest is currently working on a Travel Management Project and Environmental Assessment for the Dillon, Wisdom, and Wise River ranger districts. They are determining the usage for all roads on the three districts, which includes most of the Forest Service roads in the Beaverhead watershed. BWC will work with USFS to evaluate the Environmental Assessment and provide recommendations for road maintenance and possible road closures.

USFS is also working on a project in the headwaters of Blacktail Deer Creek. The proposed project will reduce the negative effects of grazing on West Fork Blacktail Deer Creek by installing a hardened crossing. The crossing will be designed to allow cattle to cross at a specific location, reducing damage to adjacent banks and sediment delivery to the stream.

Montana Fish, Wildlife & Parks (FWP)

FWP's priority projects in the Beaverhead watershed are the same as the priority projects listed in this WRP, with the exception of the Poindexter Slough project, which is described below.

Poindexter Slough is a 4.7-mile-long valley bottom channel of the Beaverhead River fed by a combination of groundwater and flow from the river. The lower 3.2 miles are located on an FWP fishing access site, which provides one of the few publicly accessible angling experiences on a spring-fed creek in southwest Montana. Under good habitat conditions, Poindexter Slough supports more than 2,000 adult trout per mile and excellent sport fishing. Because of its accessibility and nearness to Dillon, Poindexter Slough is heavily used, accommodating up to 4,095 angler days per year.

FWP's periodic surveys have documented a steady decline in the fishery and angler use of the slough for the past 12 years, attributing the decline to changes in irrigation practices. Adult brown trout have declined from about 2,400 fish per mile in 1999 to between 500 and 1,000 fish per mile during most of the early 21st century. Annual angler use declined commensurately during this period, from more than 4,000 angler days to a low of 610 angler days; average angler satisfaction ratings went from "excellent" to "poor."

The observed declines are primarily related to indirect habitat degradation following conversion from flood to pivot irrigation in the areas surrounding Poindexter Slough. The slough was traditionally fed largely by groundwater returning from flood irrigation. These "spring" sources were adequate to meet the irrigation demands of the Dillon Canal (which diverts its water right about halfway down the slough) and create a productive and stable fishery. When pivots replaced flood irrigation, groundwater inputs decreased, and Poindexter Slough was supplemented with increasingly more water from the Beaverhead River in order to meet the canal's water right and maintain instream flows. Diverted river water carries and deposits large amounts of fine sediment into the slough, which has progressively filled pool habitat and degraded riffle habitat. In addition, aquatic insect habitat has been reduced because of fine sediment being deposited on the streambed.

To effectively mobilize and transport fine sediment and restore habitat, infrastructure is needed to accommodate a flushing flow and eliminate backwatering caused by an irrigation diversion. Adequate flushing flows can be achieved throughout Poindexter Slough by a combination of increasing the size of the Beaverhead River headgate and selectively narrowing the channel in lower reaches. This active approach to channel enhancement would (a) increase the quantity and depth of pool habitat, (b) restore appropriate width-to-depth ratios for riffles and pools, (c) remove or isolate fine sediment deposits from the streambed, and (d) encourage natural recruitment of willows and other woody riparian vegetation. A new headgate would be installed at the top of the slough to route flushing flows of adequate magnitude and duration to mobilize and move sediment through the slough, thereby rejuvenating and maintaining restored habitat features.

To permanently eliminate backwatering and a barrier to fish movement, the Dillon Canal would be re-graded, and the elevation of its pin-and-plank control structure and headgate would be lowered. A flow management plan that describes desired magnitude and duration of flushing flows required to mobilize various-sized particles has been developed, and a new grazing management plan would be implemented to promote woody riparian vegetation on private land.

This project will enhance fish populations by improving the quality and quantity of spawning and rearing habitat, as well as improve angling quality on Poindexter Slough. In addition, it will restore aquatic macroinvertebrate habitat. The estimated restoration cost is $445,000. BWC has secured $326,160 through various grants, in-kind services, and private donations. We are presently trying to raise the final $119,000 required to complete the project.

US Bureau of Reclamation (BOR)

BWC has been working with BOR for the past 5 years to develop a sediment-flushing flow model for the upper Beaverhead River, which is directly tied to the Clark Canyon Creek sediment events. We are working with water users to determine how much water is needed and available for a flushing flow (i.e., streamflow high enough to move deposited sediment downstream) during high sediment events from the Clark Canyon Creek drainage. A memorandum of agreement is being drafted for the spring 2014 runoff season, and BWC hopes to have a flushing flow available if needed.

Other

BWC recognizes there are many other areas in the watershed in need of assistance. One of these areas in particular is the Grasshopper Creek drainage. Past grazing practices and naturally erosive banks contribute a significant amount of sediment to the Beaverhead River. A recent landowner change may make it more feasible for us to address these issues in the future.

SECTION 6: EVALUATING PROGRESS AND SUCCESS

BWC will review this WRP annually with its overall work plan then determine whether our goals and direction are still appropriate or feasible, making any necessary changes to the plan. This may include adding new priority areas or adjusting proposed BMPs or restoration actions to reflect new knowledge or science. BWC will also consult with partner agencies to ensure that priority projects are updated and evaluated.

CRITERIA AND MILESTONES FOR MEASURING PROGRESS

Criteria are indicators we can use to determine whether progress is being made (i.e., are we seeing a difference?). Possible indicators for the main issues this WRP addresses are given in **Table 6**.

Table 6. Criteria indicators that may be used to measure progress toward meeting water quality targets. Criteria that may require technical assistance are noted with an asterisk.

Water-Quality Issue	Criteria
Riparian habitat degradation	Percent of woody riparian vegetation along a reach or segment Number of feet of fencing installed Number of off-site or water gap structures installed Adoption rate of grazing management plans
Sediment loading	Total suspended solids* Sediment load reductions* DEQ sediment assessment indicators: percent fine sediment in riffles and pool tails, width:depth ratios, entrenchment ratios, residual pool depth, pools/mile, and percent greenline shrub and bare cover (to be measured against targets for each stream).* Length of roads improved or number of crossings stabilized or replaced Percent of vegetated and stable banks along a stream reach or segment
Nutrients and eutrophication	Nitrogen and phosphorus levels and load reductions* Presence of Chlorophyll-*a** Number and extent of nuisance algae blooms
Temperature/low-flow alterations	Improving trends in temperature and flow changes over time*

Milestones are benchmarks BWC will use to ensure that implementation goals are being met; they are divided into short-term (5-8 years) and long-term (8+ years) timeframes. Short-term milestones are further divided by priority project.

Short-term Milestones

- Lower Spring Creek Restoration Project (spring 2014–2016): Reduce sediment loading by 10%; eliminate direct sources of nutrient loading to the creek by moving the corral and fencing out cattle; improve riparian vegetation cover by 25% along the project's stream corridor; observe a visual reduction in chlorophyll-*a* (algae growth).

- Clark Canyon Creek: Reduce by 30% sediment entering the Beaverhead River by 2015.

- Upper Stone Creek (summer 2015): Reduce sediment loading by 15% from the main road through improved road grading, regular cleaning of sediment detention dips, and installation of streamside sediment detention structures; improve riparian vegetation cover by 25% along the primary landowner's property; install fences, water gaps, off-stream watering tanks, or hardened crossings to reduce sediment delivery along all high-delivery areas.

- Lower Stone Creek: Reduce annual nitrate loading to the creek by 20% via constructed wetlands.

- Dyce Creek: Reduce sediment loading by 15% to the east fork drainage by replacing an undersized culvert and assisting BLM in implementing recommended Environmental Assessment projects.

Long-term Milestones

- Work toward a long-term solution with landowners, BOR, and other stakeholders to reduce sediment amounts by at least 45% from Clark Canyon Creek into the Beaverhead River and provide for regular flushing flow events below the dam.

- Hold one educational workshop or tour annually to highlight a current water quality issue or project in the watershed.

- Complete one sediment reduction project per year.

Identifying the Monitoring Plan

For each implemented project or BMP, we will develop a monitoring plan to track and assess a project's effectiveness in relation to its anticipated goals. Each monitoring plan will take into account

- the question(s) we are trying to answer
- whether enough time has passed to answer these questions
- the best technique we can use to answer our questions
- the monitoring design needed to answer our questions, either qualitatively, statistically, or both

- how we will control for variability associated with weather, natural disturbances (e.g., flooding), and other issues

BWC will develop a specific monitoring plan for each project. BWC volunteers will do non-technical monitoring, such as photo plots, while hired professionals or technical partners will do more technical monitoring, such as pebble counts and cross sections. Some projects will require more technical expertise for monitoring than others. The type of monitoring techniques used will depend on the anticipated outcome, other objectives, and type of impairment or water-quality problem the restoration project or BMP is attempting to address (**Table 7**). On projects for which we partner, BWC will follow the individual partnering agency's monitoring protocols.

Table 7. Possible monitoring techniques that could be used to measure the effectiveness of projects or BMPs that address riparian habitat, sediment, nutrients, temperature, or fishery issues.

Riparian habitat	Setting permanent photograph points; NRCS riparian assessments (when feasible)
Sediment	Modeling; in-field measurements when appropriate (pebble counts, bank pins, physical bank measurements, etc.)
Nutrients	Sampling water for TN or TP; potentially sampling soil for TN and TP when appropriate; assessing chlorophyll-*a* or algal growth (including photo points)
Temperature and flow	Tracking temperature and streamflow trends and improvements using data from USGS gages, USFS, FWP, or other gaged networks, and site-specific projects
Fisheries	Conducting fish counts, redd counts, etc., in partnership with FWP

SECTION 7: REFERENCES

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