Flathead-Stillwater Watershed Restoration Plan

Final Version
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List of Acronyms

ACOE: United States Army Corps of Engineers
AIS: Aquatic Invasive Species
BMP: Best Management Practice
CMZ: Channel Migration Zone
CORE: Flathead Community of Resource Educators
CSKT: Confederated Salish Kootenai Tribes
CWA: Clean Water Act
DEQ: Montana Department of Environmental Quality
DNRC: Montana Department of Natural Resources and Conservation
DO: Dissolved Oxygen
EPA: Environmental Protection Agency
FBC: Flathead Basin Commission
FCD: Flathead Conservation District
FNS: Flathead National Forest
FRC: Flathead River Commission
FWP: Montana Department of Fish, Wildlife & Parks
HBWC: Haskill Basin Watershed Council
HCP: Habitat Conservation Plan
MACD: Montana Association of Conservation Districts
MCC: Montana Conservation Corps
MWCC: Montana Watershed Coordination Council
NPS: Non-Point Source
NRCS: Natural Resources Conservation Service
R2L: River to Lake Initiative
SWCDM: Soil and Water Conservation Districts of Montana
TMDL: Total Maximum Daily Load
TN: Total Nitrogen
TP: Total Phosphorus
USFS: United States Forest Service
USFWS: United State Fish and Wildlife Service
USGS: United States Geological Survey
WLI: Whitefish Lake Institute
WLA: Waste Load Allocation
WRP: Watershed Restoration Plan
WWTP: Wastewater Treatment Plant

Executive Summary

This document describes the water quality issues in the lakes, rivers, and streams of the Flathead-Stillwater watershed, and it outlines a pathway forward to protect and restore these valued resources. Currently, eight streams or segments of streams within the Flathead-Stillwater watershed have been identified by the Montana Department of Environmental Quality (DEQ) as having one or more pollutants negatively impacting their beneficial uses. These beneficial uses include (but are not limited to): aquatic life, agriculture, recreation, and drinking water. In addition to the eight listed streams, the Flathead Conservation District (FCD) and local stakeholders expressed concerns about pollutants negatively impacting water quality in seven other streams. These seven are considered streams of concern and are additional priorities for stakeholders.

FCD's main objective in developing this WRP is to facilitate collaboration among multiple agencies and watershed groups in the implementation of nonpoint source (NPS) pollution restoration projects. FCD does not have the capacity or the resources to lead every project, so collaboration among all agencies and groups within the Flathead Valley is essential to success in reducing NPS pollution.

This document was created in response to the completion of the *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDL and Water Quality Improvement Plan* (*Flathead-Stillwater TMDL*; 2014), which was the culmination of approximately 20 years of data analysis and water sampling by DEQ. Much of the information used to guide the development of this WRP was derived from existing DEQ reports, including the *Flathead-Stillwater TMDL*, the *Nutrient Management Plan & TMDL for Flathead Lake*, the *Water Quality Protection Plan and TMDLs for the Swan Lake Watershed* the *Water Quality Assessment and TMDLs for the Flathead River Headwaters Planning Area* documents, the *Final 2014* (and draft 2016) *Water Quality Integrated Report*, and the *2012 Montana Nonpoint Source Pollution Management Plan.*

Most of the Flathead-Stillwater watershed lies within Flathead County in northwestern Montana, and it encompasses 3,262,720 acres of land. Flathead County has become one of the fastest growing counties in Montana because of its pristine natural environment, majestic scenery, and plentiful recreational opportunities. Rapid population growth adds new stressors on land and water resources, including the addition of noxious weeds, aquatic invasive species, and NPS pollution. The population of Flathead County increased from 74,471 in 2000 to 90,928 in 2010, a large number of which are retirees and middle aged professionals (About Flathead County). Demographic trends project a 71% increase in the population of Flathead County from 2000 to 2030 (Kalispell City Planning Board, 2003). While population growth and an influx of people bring new ideas and exciting opportunities to the Flathead, concerns continue to grow about the health of aquatic ecosystems.

Section 1: Introduction

1.1 What is a Watershed Restoration Plan?

A watershed restoration plan (WRP) is a locally-developed document that provides a framework for managing, protecting, and restoring water resources. The creation of such a plan fulfills one of the requirements set forth by the Environmental Protection Agency (EPA) for groups applying for Section 319 funding of the federal Clean Water Act (CWA). The CWA establishes the basic structure for addressing discharges of pollutants (both nonpoint and point source) into Waters of the U.S. Point sources, defined as pollution that comes from a single source, are often at a point of discharge from a factory, wastewater treatment plant, or other industry. Point sources are regulated through discharge permits acquired from the Montana DEQ. The CWA has been very successful in reducing the impacts of point source pollution through this permitting process. Management of NPS pollution, however, requires a more complex approach. NPS pollution is defined as pollution arising from diffuse sources, such as land runoff, precipitation, atmospheric deposition, drainage, seepage, or manmade changes to natural waterflow. Due to the diffuse nature of NPS pollution sources, discharges into lakes, rivers, and streams can be difficult to track and manage. NPS pollutants can include oil from leaky automobiles or excess nutrients from fertilizers applied to agricultural fields or lawns. Once these pollutants are dispersed within the watershed, surface water flow, groundwater flow, or precipitation picks them up and deposits them into local waterbodies. In order to achieve and maintain target water quality standards, voluntary action by landowners and community members to implement best management practices (BMPs) is critical. WRP documents help stakeholders to holistically address NPS pollution by providing an assessment of the contributing causes and sources for their specific watershed and setting priorities for BMP implementation.

In Montana, DEQ manages WRP development and is charged with accepting individual plans. DEQ administers and distributes CWA Section 319 project funding to government or nonprofit organizations (such as watershed groups) to address NPS pollution issues based on their individually created and approved WRPs. Annual funding has been close to $1 million in recent years. DEQ puts out an annual request for proposals in June, and evaluates and approves projects by October. More information about this process can be found on the DEQ website (http://deq.mt.gov/Water/WPB/Nonpoint-Source-Program/NPS-319-Project-Funding).

The specific contents and details of a WRP are defined by local stakeholders through a collaborative process, but there are nine elements that must be identified prior to DEQ acceptance. These nine elements were created by the EPA to guide the creation of WRPs throughout the country.

1. Identify NPS pollutant causes and sources **(Section 3)**
2. Estimate NPS pollutant loading into the watershed and expected load reductions **(Section 4)**
3. Describe NPS management measures to achieve load reductions **(Section 4)**
4. Estimate technical and financial assistance needed to implement the plan **(Section 5)**
5. Develop an information/education component **(Section 6)**
6. Develop a NPS management implementation schedule **(Section 7)**
7. Describe measurable milestones **(Section 8)**
8. Identify indicators to measure progress and effectiveness **(Section 8)**
9. Develop a monitoring component to evaluate implementation effectiveness **(Section 8)**

1.2 What is an Impaired Stream and what is a TMDL?

The CWA requires that each state designate beneficial uses of their waters and develop water quality standards to protect those uses (DEQ, 2014b). Montana's water quality designated use classification system includes: aquatic life, primary contact recreation, agricultural, and drinking water. If a waterbody does not meet one or more of the standards set by the state of Montana, then it is listed as an impaired waterbody (stream or lake) by DEQ and included in the Water Quality Integrated Report (DEQ, 2014c), which is updated every two years. Waterbodies can become impaired by pollutants (e.g., nutrients, sediment, and temperature) and non-pollutants (e.g., alterations to flow or habitat).

According to both the Montana Water Quality Act and Section 303(d) of the federal CWA, waterbodies impaired by pollutants require the creation of a Total Maximum Daily Load (TMDL) document for each listed stream. The TMDL document establishes the TMDL allocation (the maximum daily amount of a pollutant a waterbody can receive and still meet water quality standards) and identifies the causes and sources of each pollutant. A TMDL allocation establishes a target for water quality to meet beneficial uses (i.e., allowable load). This target can be used to measure the success of future volunteer implementation projects. The TMDL document also describes general management measures and restoration activities that can improve water quality in impaired streams.

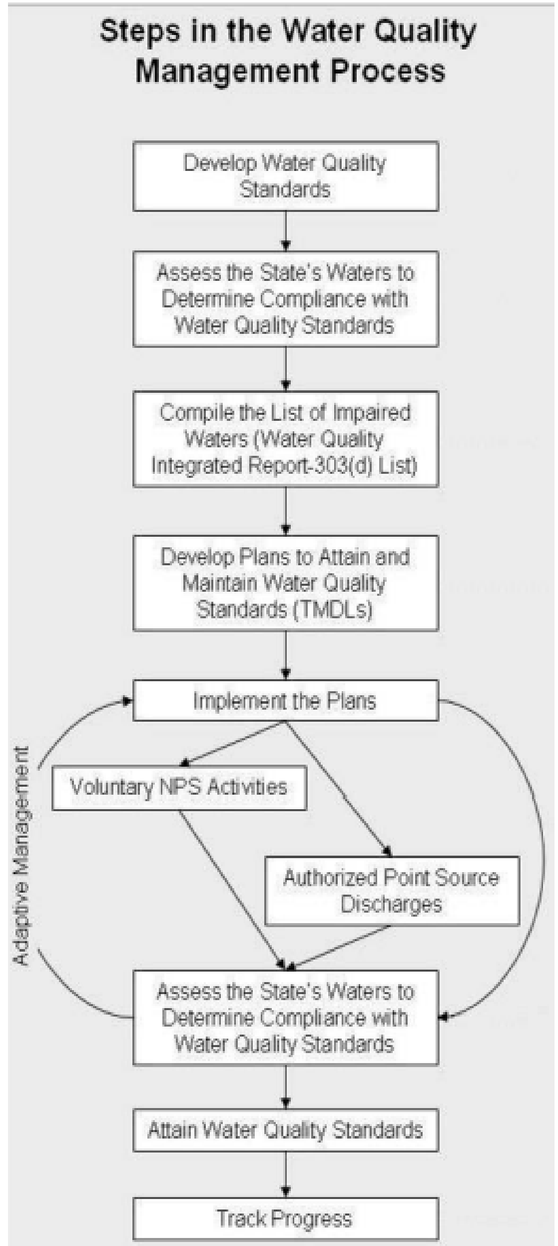

Figure 1. Montana DEQ's Adaptive Water Quality Management process

In 2014, DEQ completed a TMDL document for the Flathead-Stillwater watershed (*Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan*), which identified seven impaired streams. The TMDL also identified specific NPS issues and their possible solutions in the watershed, much of which is included in this WRP. This WRP also includes waterbodies described in *Water Quality Assessment and TMDLs for the Flathead River Headwaters Planning Area* and *Water Quality Protection Plan and TMDLs for the Swan Lake Watershed*.

1.3 What is the Purpose of the WRP?

The goal of FCD and local stakeholders is to maintain a healthy watershed that will continue to provide clean, abundant water for this and future generations. This WRP is outlines the framework for attaining this goal through the identification, coordination, and implementation of watershed restoration activities. It is intended to be a living document that will be amended periodically as water quality issues are resolved or as new ones arise.

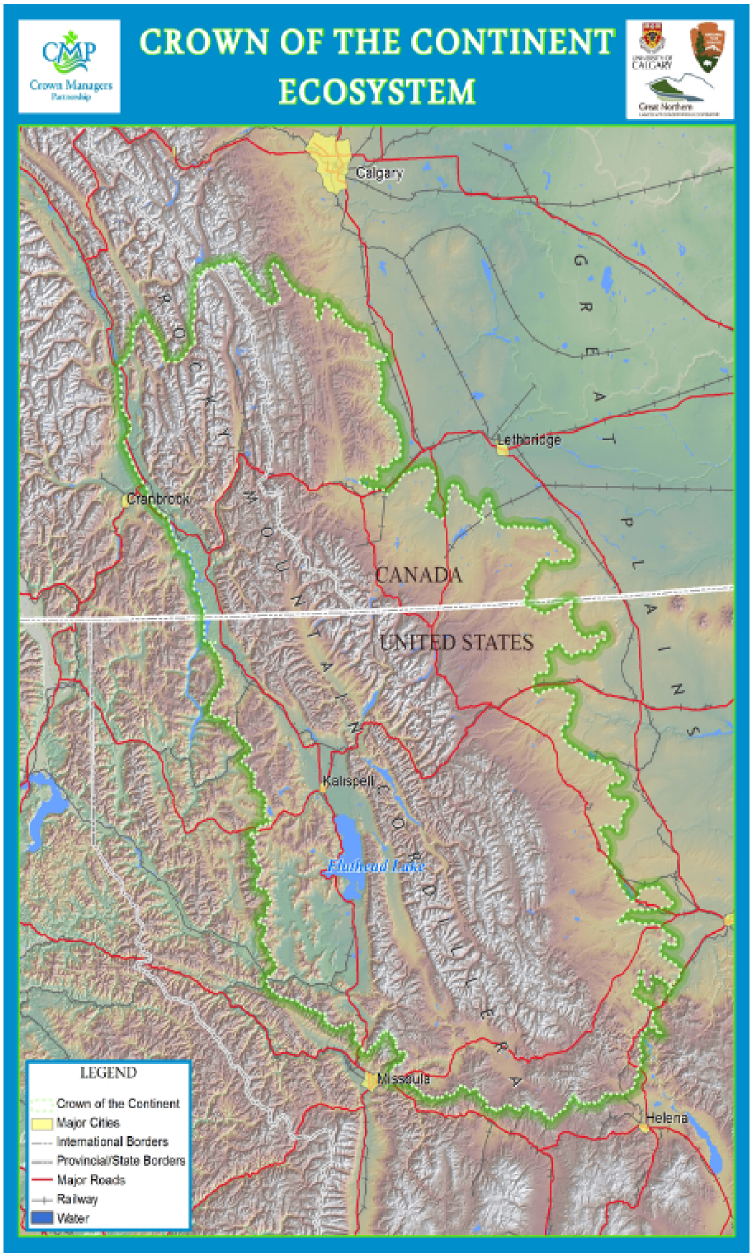

Figure 2. The Crown of the Continent ecosystem covers 18 million acres in British Columbia, Alberta, and Montana. Source: Great Northern Landscape Conservation Cooperative.

The Flathead-Stillwater watershed is part of a larger, transboundary ecosystem within Montana and Canada, known as the Crown of the Continent (Figure 2), which includes the headwaters of three continental river systems, ultimately flow into three different oceans: the Saskatchewan flowing into Hudson Bay, the Missouri flowing into the Gulf of Mexico, and the Columbia flowing into the Pacific Ocean. The Flathead-Stillwater River system is positioned at the headwaters of the Columbia River Basin. As a part of this larger ecosystem, we have a responsibility to both our local communities and the entire basin to keep our watershed healthy. Increased pressure has been placed on this watershed due to increasing urban and rural residential growth, recreational use, and the physical infrastructure necessary to support these expansions. It is imperative that efforts focus on strategies that promote stream health and continue the legacy of clean, diverse, and healthy watersheds.

The main objectives for this WRP are to:

1. Create a plan where project development will be driven by local stakeholders and to engage them in the process of implementing protection and restoration projects.
2. Form intentional long-term and short-term goals for restoration in the Flathead-Stillwater watershed.
3. Facilitate the implementation of the *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan*.
4. Bring together past and current restoration efforts of different organizations to create one plan that multiple groups can use.
5. Create a plan that can be used to receive Section 319 funding, as well as other sources of funding.

To make this WRP useful to agencies, watershed groups, and stakeholders throughout the Flathead-Stillwater watershed, FCD identified and included seven additional streams of concern in the WRP that are not listed as impaired by DEQ, but are concerns for local stakeholders and/or FCD. Restoration efforts on these priority streams may prevent future impairment listings by DEQ, but projects will not necessarily be eligible for 319 funding. Most of the streams of concern are tributaries to listed streams, and restoration efforts would also help reduce the load of pollutants entering listed streams.

1.4 Who is the Flathead Conservation District?

Conservation districts work locally to fulfill Montana's policy to conserve soil, water, and other natural resources. FCD's mission is "to conduct local activities to promote natural resources, including education, on-the-ground conservation projects, and administer the 310 Law for stream permits on perennial streams." FCD fulfills this mission by working with landowners to implement conservation practices, conducting public education to adults and youth, and overseeing the 310-permitting process in Flathead County. FCD hopes the development of this WRP will promote future restoration efforts on impaired streams throughout the Flathead Valley.

1.5 Who else is involved?

There are many agencies and organizations in the Flathead-Stillwater watershed other than FCD who have an interest in improving water quality on local rivers, lakes, and streams (Table 1). Many of these groups have implemented on-the-ground restoration work and associated education and outreach efforts in the past. Resources to support these efforts can be difficult to secure, but creation of this WRP will provide access to an additional toolset for these groups.

Table 1. Organizations committed to watershed restoration within the Flathead-Stillwater watershed.

Name of Organization	Type	Mission	Focus Areas	Received 319 Funding? *
Flathead Basin Commission www.flatheadbasincommission.org	Non-Regulatory	To protect the existing high quality of the Flathead Lake aquatic environment; the waters that flow into, out of, or are tributary to the Lake and; the natural resources and environment of the Flathead Basin.	• Aquatic invasive species prevention and education • Volunteer water quality monitoring • Transboundary protection efforts • Policy • Education/outreach	Yes
Flathead Conservation District www.flatheadcd.org	Local government	To conduct local activities to promote natural resources, including education, on-the-ground conservation projects, and administer the 310 Law for stream permits on perennial streams.	• 310 Permits • Stream restoration projects • Public education	Yes
Flathead Lakers www.flatheadlakers.org	Nonprofit	Protect clean water, healthy ecosystems and lasting quality of life in the Flathead watershed by encouraging land and water stewardship, educating about responsible and thoughtful land use planning and resource management, and building partnerships to more effectively addressing conservation priorities.	• Streambank stabilization • Protection of critical lands • Aquatic invasive species prevention and education • Water quality protection of Flathead Lake • Education/outreach	Yes
Flathead Land Trust www.flatheadlandtrust.org	Land Trust	Maintain and protect Flathead Valley's natural beauty, clean water, and special places that sustain our high quality of life.	• Watershed restoration • Protection of critical lands for fish, wildlife and bird habitat • Conservation easements	No
Flathead National Forest (FNF, USFS) www.fs.usda.gov/flathead	Federal	To provide for long-term direction to guide the management of the Flathead National Forest. Identifies suitable uses of National Forest System lands, identifies priority watersheds for restoration, and includes areas being recommended for wilderness designation and eligible Wild and Scenic Rivers.	• Wildlife protection • Fisheries protection • Watershed restoration • Education/outreach • Noxious weeds/aquatic invasive species prevention • Scientific research, observation, monitoring	No

Name of Organization	Type	Mission	Focus Areas	Received 319 Funding? *
Flathead River Commission www.flatheadcd.org/watershedgroups/flathead-river-commission	Local Landowner Volunteers	To maintain and improve water quality within the Flathead watershed by developing and implementing new strategies, seeking funding for projects and further education, and working to make stabilization and restoration more affordable and simple. FRC focuses their efforts on the lower 22 miles of Flathead River in the lake effect zone.	• Policy • Education/outreach • Fund research/studies	Yes
Haskill Basin Watershed Council www.flatheadcd.org/watershedgroups/haskill-basin-watershed-council	Local Landowner Volunteers	Maintain and enhance the chemical, biological, and physical integrity of Haskill Creek through a voluntary and cooperative effort.	• Streambank stabilization • Local policy • Flow monitoring	No
MT Department of Environmental Quality (DEQ) www.deq.mt.gov	State	Protect, sustain, and improve a clean and healthful environment to benefit present and future generations.	• Enforcement of natural resource laws • Regulatory • Promote alternative energy forms • Water and air quality	No
MT Department of Natural Resources and Conservation (DNRC) – Kalispell Regional Office www.dnrc.mt.gov	State	Helps ensure that Montana's land and water resources provide benefits for present and future generations.	• Conservation and resource development • Forestry • Oil and gas conservation • Reserved water rights compact commission • Trust land management • Water resources	Yes
MT Fish, Wildlife and Parks	State	Provides for the stewardship of the fish, wildlife, parks and recreational resources of	• Watershed restoration • Natural resources management	No

Name of Organization	Type	Mission	Focus Areas	Received 319 Funding? *
(FWP) – Region 1 Office www.fwp.mt.gov/regions/r1		Montana, while contributing to the quality of life for present and future generations.	• Fishing and hunting regulation • Land conservation	
Weyerhaeuser Company www.weyerhaeuser.com	Private Timber Company	To provide premier timber, land, and forest products through sustainable practices to meet the needs of shareholders, customers, employees, and communities.	• Silviculture • Timber harvesting • Land and water management • Energy development	No
Whitefish Lake Institute www.whitefishlake.org	Nonprofit	Committed to science, education, and community stewardship to protect and improve Whitefish Lake and Whitefish area water resources today, while providing a collective vision for tomorrow.	• Scientific research • Education/outreach • Community stewardship • Watershed restoration	No

*Appendix A lists 319 projects applied for since 2002 by these organizations and how much money was received.

Section 2: Identifying the Watershed and its Impaired Waters

This WRP focuses on the Flathead and Stillwater watersheds (Figure 3). The Flathead watershed is located in northwestern Montana and southwestern Canada, and includes all of the land that drains into Flathead Lake. It begins north of the US-Canadian border, and it extends south to the Clark Fork drainage, west to the Salish Range, and east to the Continental Divide. The Stillwater watershed includes the Stillwater watershed and the northern section of the Flathead Lake watershed. Together, the Flathead-Stillwater watershed shares boundaries with the Whitefish mountain range in the north, the Swan River mountain range in the east, the Upper Kootenai and Fisher River drainages in the west and Flathead Lake in the south. It covers approximately 1,430 square miles and is located mostly within Flathead County, with small northern and western portions reaching into Lincoln County. The impaired streams originate in the Salish Mountains and Whitefish Range, and all streams found in the Flathead-Stillwater watershed ultimately drain into Flathead Lake. Figures 3-8 and Table 2 identify the Flathead watershed, the Flathead-Stillwater watershed, the impaired streams within the Flathead-Stillwater watershed, and land cover and population density characterizations for the Flathead-Stillwater watershed (DEQ, 2014b).

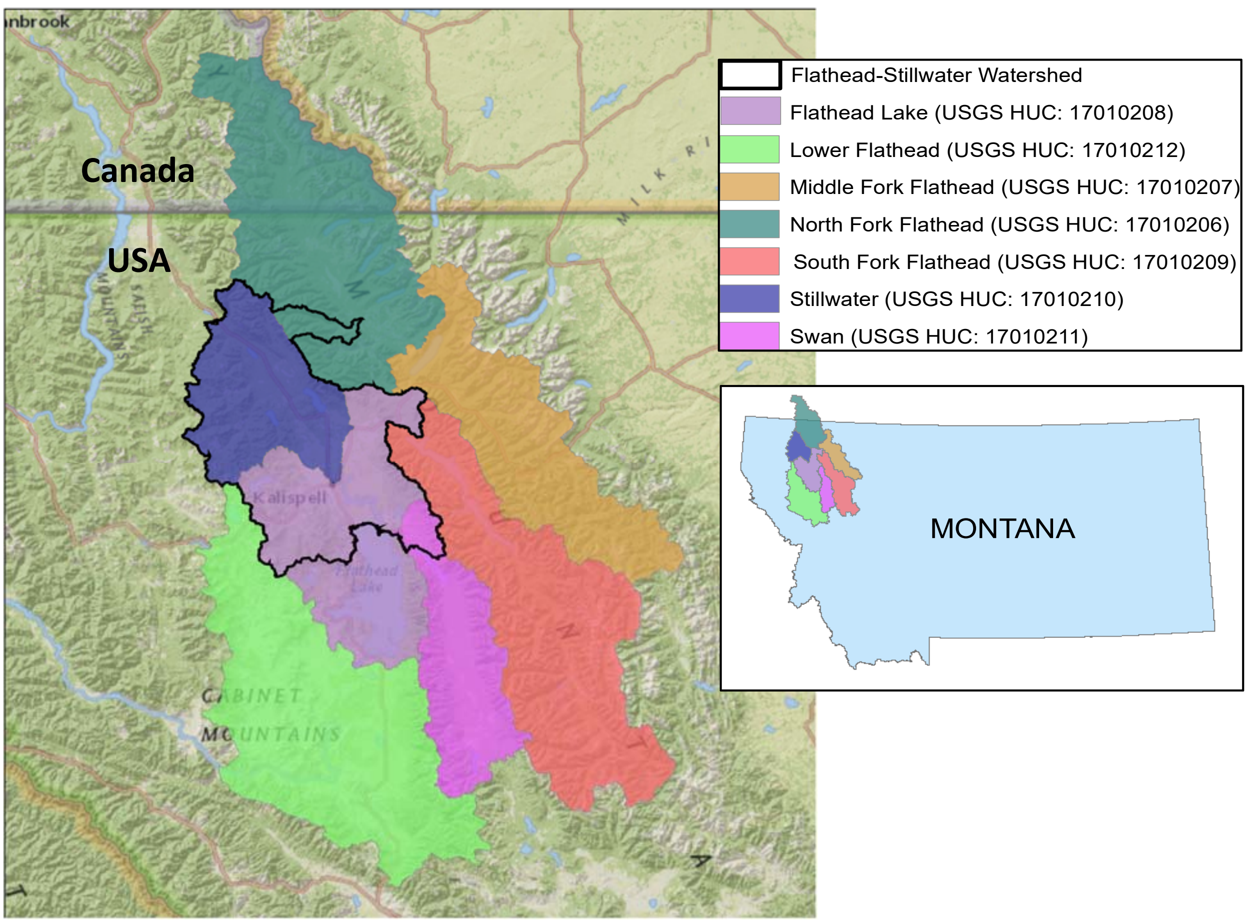

Figure 3. Flathead watershed showing the Flathead-Stillwater watershed outlined in black. The Flathead-Stillwater watershed consists of two main sub-watersheds with small inclusions from two other surrounding sub-watersheds. Watershed data provided by MT GIS Portal (Hydrologic Units).

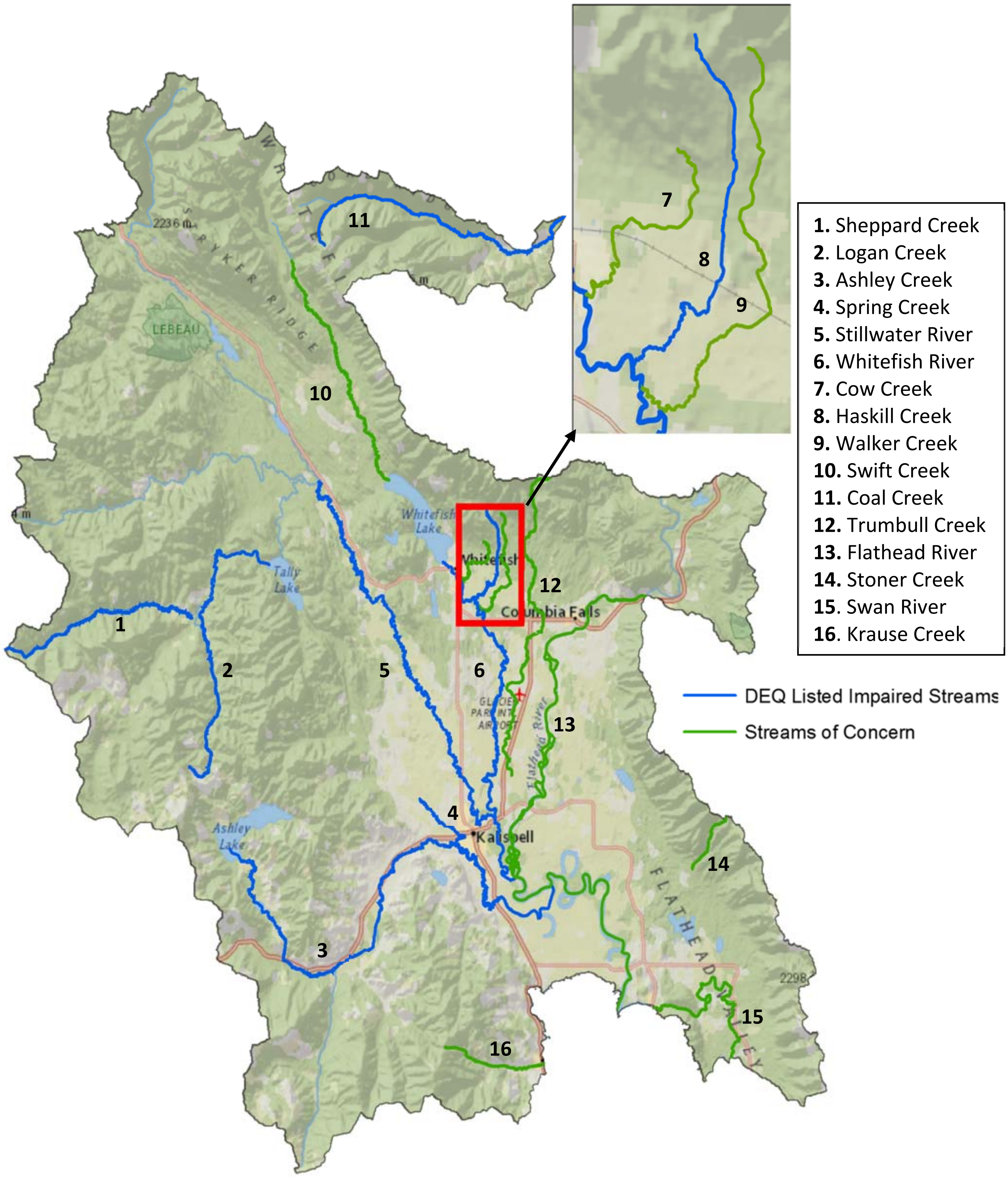

Figure 4. Locations of DEQ listed streams and other streams of concern. Stream data provided by MT GIS Portal (National Hydrography Dataset).

Table 2. Waterbodies in the Flathead-Stillwater watershed on Montana DEQ's list of impaired waters (DEQ, 2014b) and additional streams of concern. The highlighted rows indicate streams of concern (non-DEQ listed streams).

Water Body	Probable Causes of Impairment										Impaired Use(s)		
	Total Nitrogen	Total Phosphorous	Sediment	Temperature	Alteration in stream -side vegetation	Low flow alterations	Other flow regime alterations	Physical substrate habitat alterations	Chlorophyll-a	Flooding (Not a listed impairment)	Aquatic Life	Primary Contact Recreation	Stream of Concern Not Listed as Impaired by DEQ
(Upper) Ashley Creek – Ashley Lake to Smith Lake	X		X	X	X				X		X	X	
(Middle) Ashley Creek – Smith Lake to Kalispell Airport Road	X	X	X	X		X					X	X	
(Lower) Ashley Creek – Kalispell Airport Road to mouth (Flathead River)	X	X	X	X	X				X		X	X	
Coal Creek – Headwaters to mouth (North Fork Flathead River)			X		X						X		
Cow Creek – Headwaters to mouth (Whitefish River)	X	X	X	X	X								X
(Lower) Flathead River – Columbia Falls to Flathead Lake	X	X	X		X								X
Haskill Creek – Haskill Basin Pond to mouth (Whitefish River)			X								X	X	
Krause Creek – Headwaters to mouth (Echo Lake)			X										X
Logan Creek – Headwaters to Tally Lake			X				X	X			X		
Sheppard Creek – Headwaters to mouth (Griffin Creek)			X		X						X		
Spring Creek – Headwaters to mouth (Ashley Creek)	X	X			X		X	X			X	X	
Stillwater River – Logan Creek to mouth (Flathead River)			X		X						X		
Stoner Creek – Headwaters to mouth (Flathead Lake)			X										X
(Lower) Swan River – Swan Lake to Flathead Lake			X										X
Swift Creek – Headwaters to mouth (Whitefish Lake)			X		X								X
Trumbull Creek – Headwaters to mouth (Stillwater River)			X			X				X			X
Walker Creek – Headwaters to mouth (Whitefish River)	X	X	X	X	X	X							X
Whitefish River – Whitefish Lake to mouth (Stillwater River)				X							X		

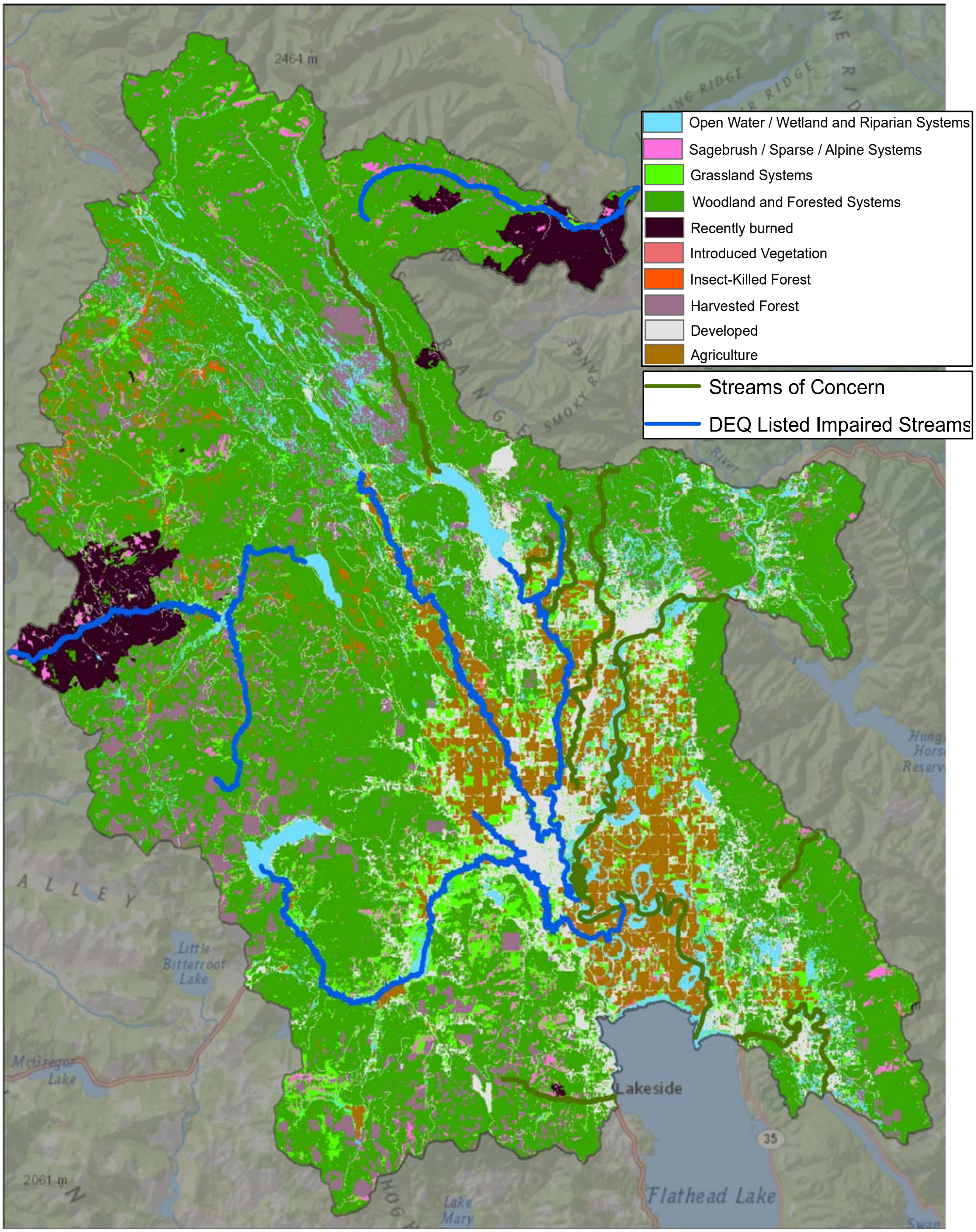

Figure 5. Primary land cover of the Flathead-Stillwater watershed. Landcover data provided by MT GIS Portal (Montana Land Cover Framework 2016 – Montana Natural Heritage Program).

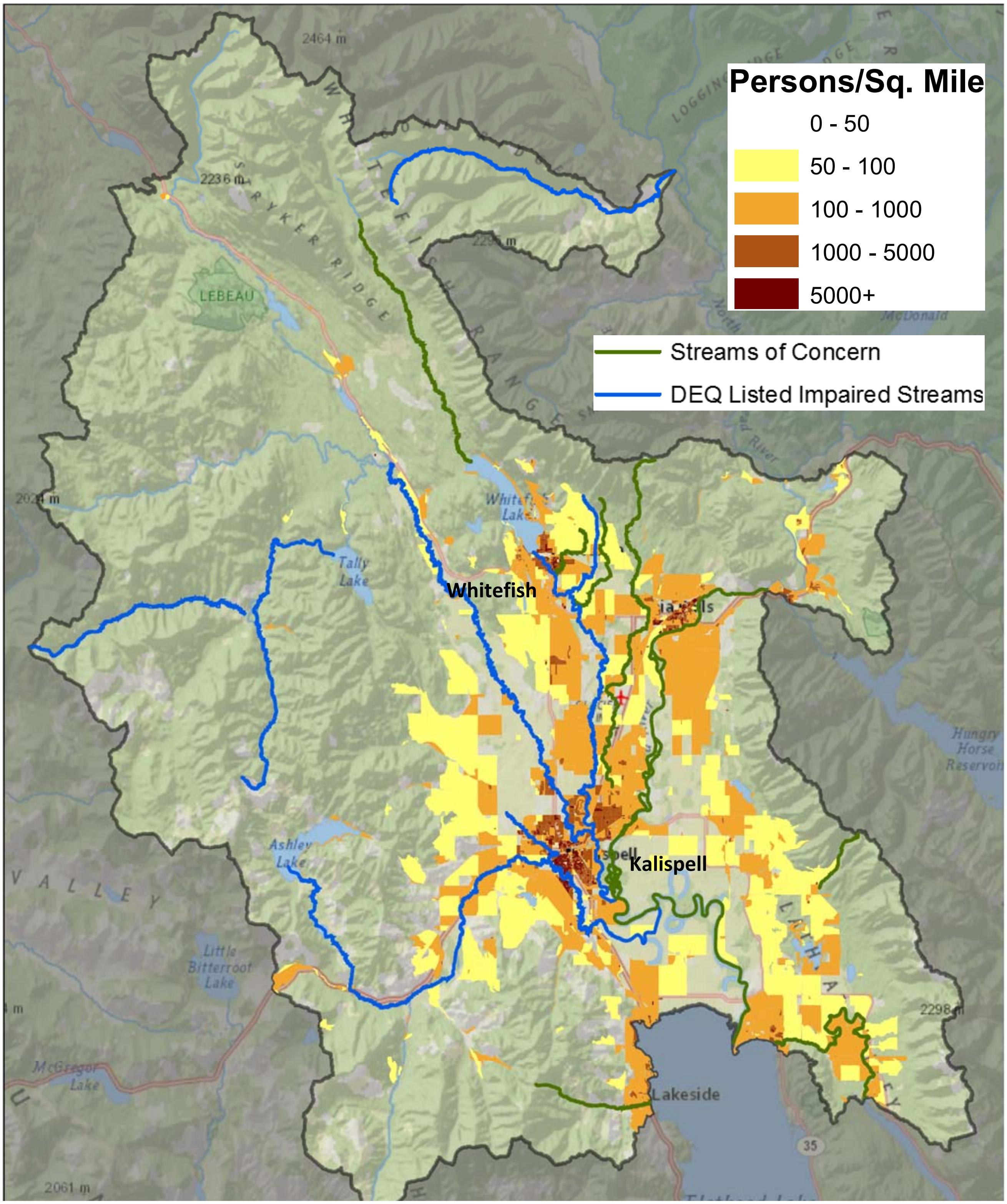

Figure 6. Population density in persons/sq. mile in the Flathead-Stillwater watershed. 2010 census data provided by MT GIS Portal (Montana Census Blocks with Population Data, 2010).

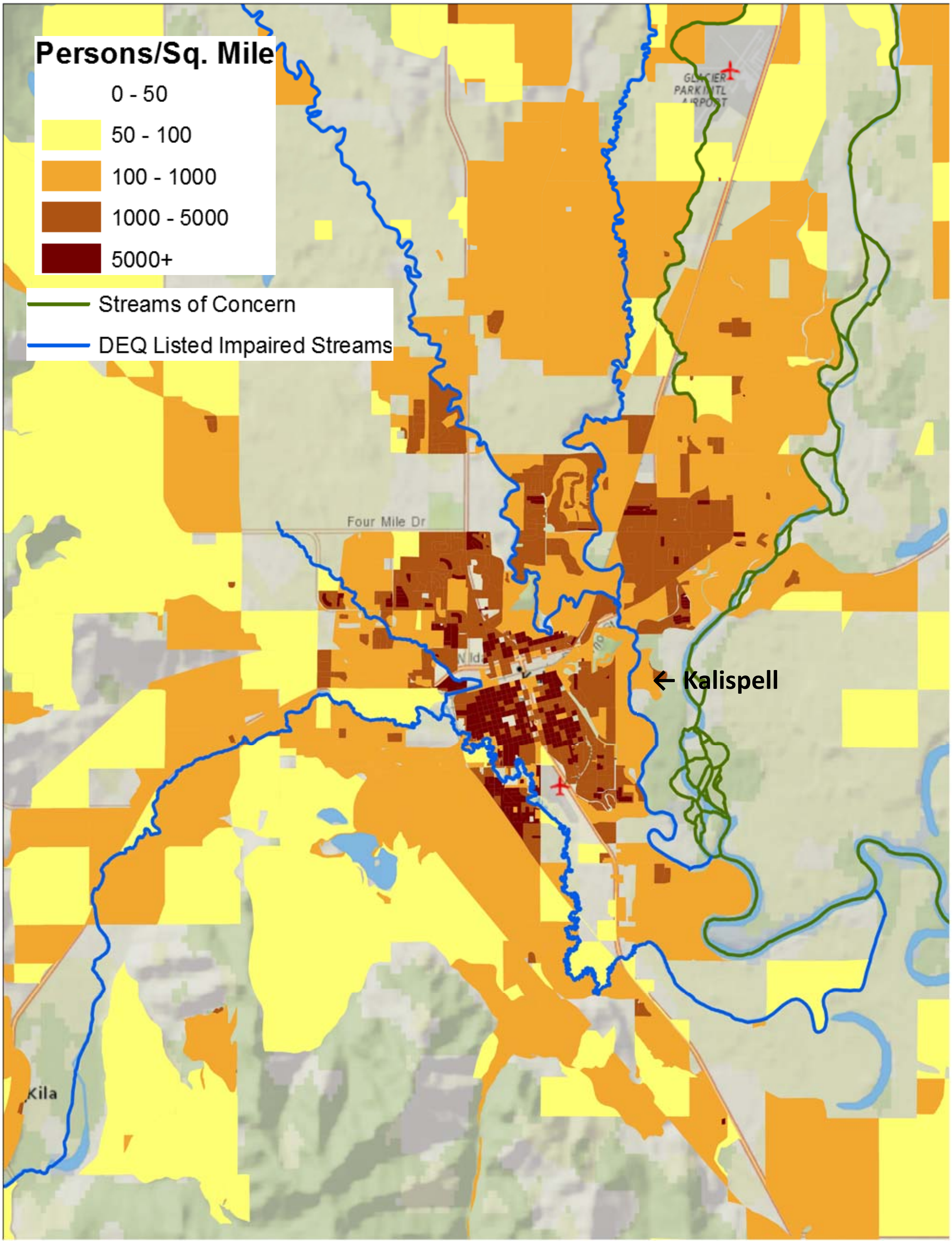

Figure 7. Close-up of Kalispell and surrounding area population density. 2010 census data provided by MT GIS Portal (Montana Census Blocks with Population Data, 2010).

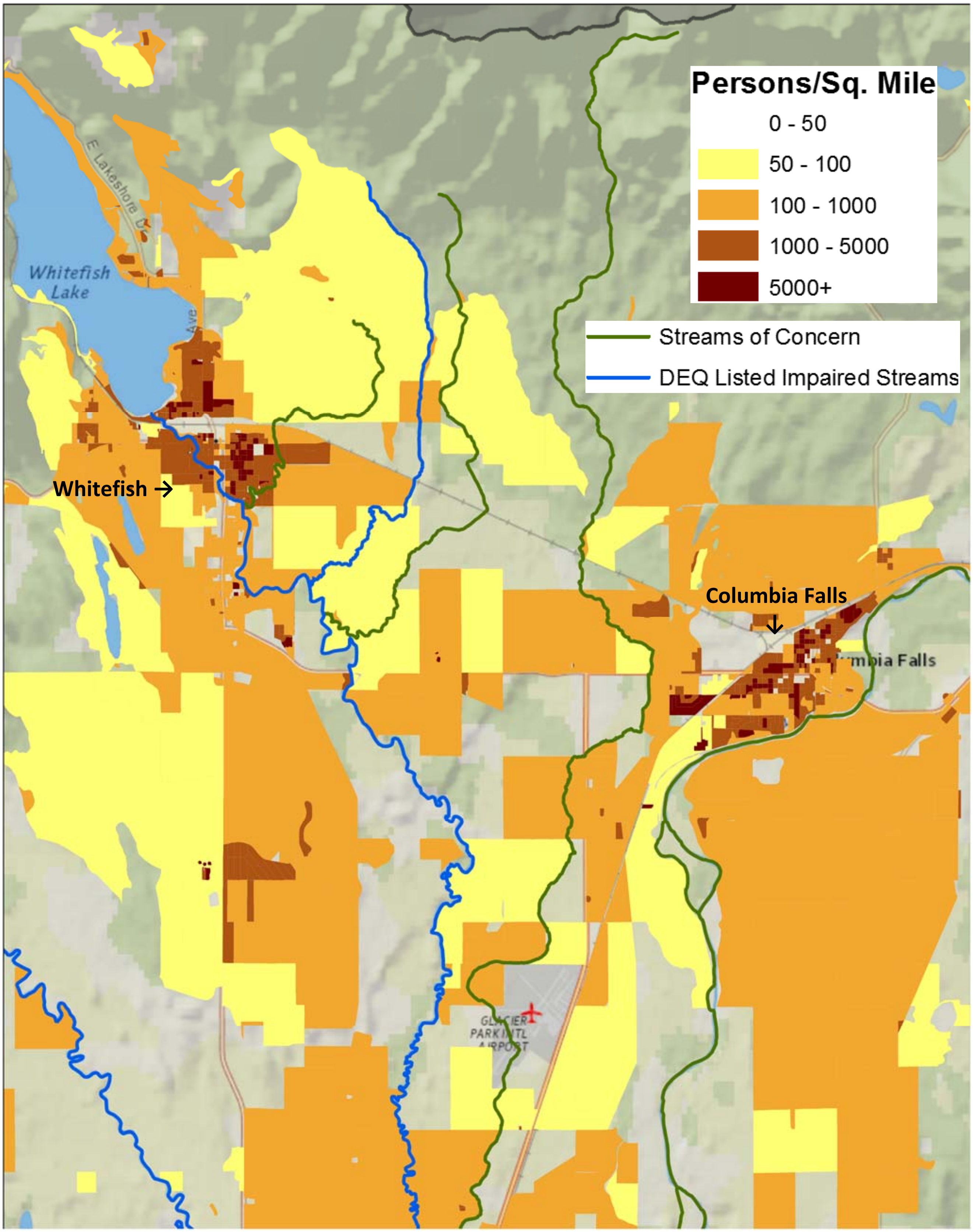

Figure 8. Close-up of Whitefish and Columbia Falls population density. 2010 census data provided by MT GIS Portal (Montana Census Blocks with Population Data, 2010).

Section 3: Identifying Causes and Sources of NPS Pollution and Other Threats

The information contained in this section identifies probable causes and sources of NPS pollution within the Flathead-Stillwater watershed. A “cause” refers to the pollutant that drives a specific impairment, such as sediment, nutrients, or temperature. A “source” refers to the activity or entity from which a pollutant is derived, such as fertilizer application or loss of riparian habitat. This section also contains information about other threats to local waterbodies within the Flathead-Stillwater watershed, such as aquatic invasive species (AIS), which are concerns to local stakeholders. Additional information about specific causes and sources of NPS pollution for impaired waterbodies in Montana can be found on the Clean Water Act Information Center website at http://svc.mt.gov/deq/dst/#/app/cwaic.

3.1 Sediment Causes and Sources

Eight sediment TMDLs were created for the Flathead-Stillwater watershed: Upper, Middle, and Lower Ashley Creek, Haskill Creek, Logan Creek, Sheppard Creek, Coal Creek, and Stillwater River. While erosion and deposition of sediment are naturally occurring components of stable stream and lake ecosystems, human influences can contribute unnaturally high rates, which can be detrimental to aquatic life. Excess sediment loading in the water can increase turbidity, block sunlight, and reduce rates of primary production. Fine sediment can also settle into stream substrate (e.g., pebbles or cobbles) and interfere with fish and macroinvertebrate survival and reproduction. The sediment TMDLs for all eight impaired stream reaches identify roads, streambank erosion, and upland erosion as major sources of sediment loading in the watershed area (DEQ, 2014b).

Streambank Erosion

Streambank erosion is a natural process. Thousands of years of erosion and deposition have formed the mosaic of ecosystems present within the Flathead River corridor. However, anthropogenic impacts can increase erosion and sediment inputs, as well as limit a stream’s ability to transport and deposit sediment. Loss of riparian vegetation reduces the stability of streambanks over time. Excessive erosion can result in channelization and exacerbate downcutting. Streambank erosion can be addressed by increasing riparian vegetation and ensuring that streams have access to their floodplains during spring runoff. Streambank erosion currently contributes an estimated 16,797 tons of sediment annually to the Flathead-Stillwater watershed from impaired streams; of this, 95% is attributable to human sources (Montana Dept. of Environmental Quality, 2014). DEQ estimates that most human-caused bank erosion sources can be reduced to 16,025 tons by encouraging landowners and other organizations to implement BMPs.

Upland Erosion

Upland erosion contributes approximately 5,403 tons of sediment annually to the Flathead-Stillwater watershed from impaired streams; of this, 22% is attributable to controllable human sources. DEQ estimates that a 50% reduction (592 tons annually) in controllable human sources would result in allowable upland erosion loads. Upland erosion includes sediments that are eroded from beyond the stream channel and erosion rates are influenced by land use and/or vegetative cover of upland areas. Human-caused sources of upland erosion (e.g., agriculture, timber harvest, golf courses) typically contribute a fairly small sediment load to impaired streams in comparison to streambank erosion, but they are sources that can be controlled through the implementation and maintenance of BMPs.

Unpaved Roads

Unpaved roads contribute approximately 271 tons of sediment annually to the Flathead-Stillwater watershed from impaired streams. DEQ estimates that a 30% reduction in sediment load from unpaved roads achieve an allowable load of approximately 193 tons of sediment annually. Roads located near stream channels can negatively affect stream function by degrading riparian vegetation, reducing floodplain access from stream channelization, and directly delivering sediment loads from the road surface. Culverts can be substantial sources of sediment when not installed properly and/or when not appropriately sized. Road crossings can also contribute sediment if not properly maintained.

3.2 Temperature Causes and Sources

Four temperature TMDLs were created for the Flathead-Stillwater watershed: Upper, Middle and Lower Ashley Creek and the Whitefish River. The primary cause of impairment is lack of riparian vegetation. Restoring the riparian vegetation, as well as maintaining stable stream channel bankfull width and instream discharge conditions during the hottest summer months, are important for meeting TMDL temperature reduction goals. A primary concern with rising stream temperatures are the effects warmer water has on native fish populations, such as westslope cutthroat trout, which is listed as a species of concern in Montana and occur in Ashely Creek and Whitefish River. Without proper management, these native fish have potential to be out-competed by non-native fish species that are adapted to warmer temperatures (DEQ, 2014b).

Riparian Health – Shade

Riparian vegetation provides shade and intercepts direct sunlight before it reaches a waterbody. Its presence also reduces near-stream wind speed and traps air against the water surface, which reduces heat exchange with the atmosphere. Lastly, a lack of established riparian vegetation can increase streambank erosion, leading to over-widened streams, which increases surface area for solar radiation. In the Flathead-Stillwater watershed, the most significant loss of riparian vegetation has come from present and historical agricultural activities, timber harvest, and recreational activity. DEQ estimates that riparian vegetation needs to be improved on 24% of Upper Ashley Creek, 78% of Middle Ashley Creek, and 87% of Lower Ashley Creek to achieve estimated temperature reductions. The Whitefish River needs riparian vegetation improvement on 47% of its streambanks to reach target temperature reductions.

Channel Bankfull Width

The width and depth of a stream can affect the water temperatures. A narrower channel with a lower width to depth ratio results in a smaller contact area with warm air and is slower to absorb heat. A narrower channel also increases the effectiveness of shading produced by the riparian canopy. The target listed in the TMDL is no increase in channel width due to human-caused sources because observations suggest the potential to reduce stream channel width in either Ashley Creek or the Whitefish River is minimal. If specific locations have the potential to become narrower, improved vegetation in riparian areas will generally lead to gradual reductions in channel widths over time. Average widths should stay between 16 - 25 ft. for Upper Ashley Creek, 24 – 42 ft. for Middle Ashley Creek, 26 – 94 ft. for Lower Ashley Creek, and 63 – 80 ft. for the Whitefish River.

Instream Discharge (Streamflow Conditions)

Due to the high specific heat of water, large volumes require more solar energy to heat than smaller volumes of water; thus, streams with low flow discharge are more likely to experience temperature impairments than higher flow streams. Reductions in streamflow are often attributed to irrigation diversions for agriculture or residential use. Over time, the efficiency of the structures used to divert water declines, and, therefore, regular maintenance and/or replacements are important to maintain instream flow. Voluntary actions by urban residents to use less water on their lawns during the summer would also improve instream flow. Target reductions would reduce withdrawals to increase instream flows by 15% on Ashley Creek. No irrigation withdrawals or return flows were identified along the Whitefish River during the 2008 assessment.

3.3 Nutrient Causes and Sources

Streams require a balance of nutrients, and nutrient influxes from anthropogenic sources can increase algal growth, which lowers levels of dissolved oxygen and creates toxic conditions to humans, aquatic life, wildlife and livestock (DEQ, 2014b). Four nutrient TMDLs (total nitrogen and total phosphorous) were created for Upper, Middle, and Lower Ashley Creek and Spring Creek. The following nutrient contribution sources were considered during nutrient TMDL modeling: agriculture, atmospheric deposition, streambank erosion, forest fire, natural background sources, point sources, Smith Lake wetland complex, septic systems, timber harvest, and unpaved roads.

Septic Systems

Septic systems contribute both phosphorus and nitrogen into the Ashley Creek watershed, which includes Spring Creek as a tributary. Septic systems comprise 6% of nitrogen loading in Upper Ashley Creek, 17% of nitrogen and 20% of phosphorus in Middle Ashley Creek, 15% of nitrogen and 20% of phosphorus in Lower Ashley Creek, and 50% of nitrogen and phosphorus in Spring Creek. These contributions may increase significantly as residential development in the area continues to trend upward. As Ashley Creek flows downstream towards the Flathead River and Kalispell, population density increases, as does septic waste contribution to subsurface flow. Spring Creek is especially susceptible to septic contributions due to the high ratio of residential development to stream length. The Ashley Creek watershed contains 3,353 septic systems, and 182 of these are less than 100 feet away from the shores of Ashley or Spring Creeks.

Agriculture

Agricultural practices can contribute significant amounts of nutrients to water systems if proper BMPs are not utilized. Nutrient loading from agriculture is affected by fertilizer application, livestock watering in streams, types of crops or cover crops planted, angle at which fields are plowed, and lack of a riparian vegetative buffer between shorelines and fields. Agricultural lands make up 6% of the entire Ashley Creek watershed and 61% of Spring Creek.

Urban Areas

Urban areas can contribute nutrients to streams in a number of different ways, but the extent of nutrient loading from urban areas is primarily related to the type of development and how close to the shoreline development occurs. Urban and residential development usually leads to riparian degradation, which reduces the ability of riparian areas to effectively filter nutrients from upland runoff. About 3% of the Ashley Creek watershed is classified as urban, while 24% of Spring Creek is classified as urban.

Smith Lake Wetland Complex

There is a large complex of wetlands between Ashley Lake and Smith Lake that may be contributing significant loads of nitrogen and phosphorus to Ashley Creek. It is unclear if this is natural or if the release of nutrients from the wetlands is being driven by anthropogenic activities. Further monitoring and investigation has been conducted by DEQ to better understand the system and more accurately characterize nutrient loads. Nutrient sampling was conducted between July and September of 2015 and between January and March of 2016. Flow and gauge data collection at the Ashley Lake outlet occurred throughout 2015 and 2016. These data are currently under analysis, but, once complete, they will help refine the Ashley Creek portion of the Flathead Lake nutrient model and provide better overall loading estimates to Flathead River and Flathead Lake. The relative nutrient loading in Ashley Creek will be refined as necessary after a more complete picture of the sources is developed.

Natural Background and Atmospheric Deposition

Streams naturally experience seasonal and annual fluctuations in nutrient inputs. Natural background land types considered for this analysis included: barren, forest, herbaceous, snow/ice, water, and wetland. Nutrients can also be added to the water system via air and atmospheric deposition. This occurs when nutrients, either naturally occurring or excess from human activities, are transported through wind or rain and are deposited elsewhere on the landscape (DEQ, 2014b).

Unpaved Roads

Degraded and poorly maintained unpaved roads contribute phosphorous from eroding sediment. DEQ identified 409 miles of unpaved roads within the Ashley Creek watershed (including Spring Creek). Currently, 92 of those miles are within 100 meters of perennial streams; thus, they have the greatest impact on nutrient loading in the watershed.

Other Nutrient Sources

A variety of other nutrient sources, including forest fires, golf courses, and timber harvest, can also contribute nutrient loads to a stream system, but DEQ determined that these sources are not significant. Implementing BMPs to mitigate the nutrient loading from the above described nutrient sources will work to mitigate any effects caused by fires, golf courses, timber harvest and bank erosion, thus, it is important to keep these sources in mind.

3.4 Non-Pollutant Impairments

Non-pollutant impairments occur when there is a change in the environment caused by humans that affects a waterbody or its biological community. These impairments may cause a waterbody to be included on Montana's list of impaired waters, but they do not require a TMDL. Non-pollutant impairments are often associated with a specific NPS pollutant cause of impairment, but can also affect water quality without a clearly defined linkage to a pollutant. They are often used as a probable cause of impairment when available data at the time of the water quality assessment do not provide a direct, quantifiable linkage to a specific pollutant. If measures are taken to reduce the loads of sediment, temperature, or nutrients in a waterbody, then these non-pollutant impairments should improve as well (DEQ, 2014b). Currently, eight of the nine impaired streams in the Flathead-Stillwater watershed are listed for one or more of these non-pollutant impairments.

Dissolved oxygen (DO)

Most aquatic life relies on dissolved oxygen (DO) for respiration, which is essential for survival. Typically, free-flowing, unpolluted streams have sufficient DO concentrations to support fish and other aquatic life, but changes in DO concentrations can negatively affect aquatic life (DEQ, 2014b). Changes in stream DO concentrations are often an indirect response to one or more anthropogenic variables, such as changes in nutrients, algae, stream temperature, habitat alteration, and sediment. Nutrient inputs to streams increase primary production and algal growth, which depletes DO, and, thus, results in lower overall DO concentrations. Streams with higher temperatures also have lower DO concentrations because warm water holds less DO than cold water. Measured DO concentrations in Upper Ashley Creek, Lower Ashley Creek and Spring Creek are lower than DEQ standards.

Chlorophyll-a

Chlorophyll-a is a measure of the concentration of photosynthetic pigments that occur in algae. Therefore, increases in algal growth drive increase in chlorophyll-a concentrations. Excessive algal growth impairs aquatic life or primary contact recreation designated uses. Disproportionate nutrient loads can cause algal blooms that also decrease DO concentrations. Ashley and Spring Creeks are currently listed as affected by chlorophyll-a.

Alteration in stream-side or littoral vegetative covers

This impairment refers to instances when the stream channel has been altered or riparian vegetation has been removed, both of which affects channel geomorphology. Causes of this impairment include overgrazing by livestock or removal of vegetation for a road. Alteration or removal of riparian vegetation results in bank destabilization, over-widened stream channel conditions, elevated sediment and/or nutrient loads, and increased water temperatures due to lack of shade cover. Ashley Creek, Spring Creek, Sheppard Creek, Coal Creek and the Stillwater River are listed for this impairment.

Low-flow alterations

Irrigation withdrawals from streams are the main driver of low-flow alterations impairments because they lower the base flow of streams. This results in dry channels or extreme low-flow conditions, both of which are unable to fully support aquatic life. Shallow, low-flow conditions absorb thermal radiation more readily, which increases stream temperatures and lowers DO concentrations. A low-flow alteration impairment cannot be used to diminish a legally-recognized water right, but it is an opportunity to understand the impacts of the flow alterations and pursue solutions that can improve stream flows during critical periods (DEQ, 2014b). Currently, Ashely Creek is the only listed stream to be affected by this impairment, though other streams within the Flathead-Stillwater watershed experience dewatering. FWP has an online GIS data set identifying man-made dewatered streams in Montana. This data set identifies both Ashley Creek and Trumbull Creek as periodically dewatered and Walker Creek as chronically dewatered. This information is available from FWP: http://data.mtfwp.opendata.arcgis.com/datasets/e0849312c41b415992a075f8696164c8_0?geometry=-114.867%2C48.161%2C-113.955%2C48.435.

Physical substrate habitat alterations

Physical alteration of the morphological structure of streams, such as straightening of the channel or human-influenced downcutting, results in decreased morphological complexity and a loss of habitat for aquatic life. Streams may have been straightened in the past to accommodate roads or agricultural fields. Spring and Logan Creeks are affected by this impairment. Additionally, FCD has identified this as an impairment on Trumbull Creek and Krause Creek.

Other flow regime alterations

This impairment refers to a change in the flow characteristics of a waterbody relative to natural conditions. This is associated with changes in urban development, road construction, or timber harvest. Road crossings with undersized culverts can alter flows by causing water to backflow upstream of the culvert. Spring and Logan Creeks are currently listed for this impairment. Additionally, FCD has identified flow regime alterations as impairments on Krause Creek, Haskill Creek, and the Flathead River.

3.5 Other Water Quality Pollutants and Threats

In addition to the NPS pollutants included in the Flathead-Stillwater TMDL, several other NPS pollutants were identified in the 2014 (and 2016) *Water Quality Integrated Report* for streams and lakes in the Flathead Lake and Flathead-Stillwater watersheds (Table 3). Possible sources of these pollutants include: transportation, urban/suburban activities, recreation and atmospheric deposition. These will require future TMDL documents.

Table 3. Waterbodies in the Flathead-Stillwater and Flathead Lake watersheds with pollutant impairments on the 2014 (and 2016) 303(d) list not addressed in this document.

TMDL Planning Area (TPA)	Waterbody & Location Description	Impairment Cause
Flathead Lake	**Flathead Lake**	Mercury, Polychlorinated biphenyls (PCBs)
Flathead - Stillwater	**Spring Creek**, Headwaters to mouth (Ashley Creek)	Arsenic
	Whitefish Lake	Mercury, Polychlorinated biphenyls (PCBs)
	Whitefish River, Whitefish Lake to mouth (Stillwater River)	Oil and Grease, PCB in Water Column

The introduction and proliferation of aquatic invasive species (AIS) pose another threat to the Flathead-Stillwater watershed. AIS are pathogens, plant, or animal species that invade aquatic ecosystems beyond their natural, historic range and negatively affect commercial, agricultural, and recreational activities. Though not classified as a pollutant, AIS can drastically alter the habitat and food web by outcompeting native species.

Increases in residential and urban development throughout the Flathead-Stillwater watershed poses another growing threat to water resources. Flathead County is one of the fastest growing counties in Montana, and urban development has the potential to increase stormwater runoff and residential wastewater disposal, as well as alter or destroy riparian and wetlands areas. Residential and urban development increases the area of impervious surfaces found in the watershed, which restricts the amount of precipitation that can infiltrate into the ground, thus, promoting greater runoff. Increased stormwater runoff accelerates NPS pollution loading into streams and lakes. Increased development also adds to the amount of pollution occurring from septic systems, landfill waste, and hazardous chemicals and materials. Septic systems have the potential to affect groundwater quality by leeching nutrients, pathogens, and chemicals into subsurface flow, which eventually enters into surface water. Increased urban development poses a threat to critical lands in the Flathead Valley, including: floodplains, wetlands, and riparian forests. These areas are not only important for wildlife habitat and recreational uses, but serve as a filter that traps pollutants before they can enter a waterbody. Destruction of critical lands will increase levels of nutrients, sediment, bacteria and algae; create higher summer water temperatures; increase amounts of channel erosion; and exacerbate flood events.

Lastly, noxious weeds are an ongoing problem for most landowners in the Flathead Valley. Noxious weeds are non-native plants that grow and spread aggressively, often in disturbed environments. Some are poisonous to humans and livestock, and most will out-compete desirable and native vegetation. They can reduce crop yields, damage and destroy recreational opportunities, clog waterways, and diminish land values. Noxious weeds can affect water quality by increasing upland sediment erosion loads into waterbodies. Unlike native grasses and forbs, which have wide-spreading fibrous roots, these weeds often only have a single tap root, which causes soil instability and increases the amount of surface erosion occurring in fields. The Flathead County Weed Control District is mandated by state law to control noxious weeds, and it requires landowners to work together to identify noxious weeds and help eradicate and control nuisance populations.

3.6 Permitted Point Sources of Pollution

Point source pollution sources have a specifically identifiable point of entry into the watershed and, unlike nonpoint sources, are regulated through state or federal permitting requirements. Point sources include the many different commercial and industrial facilities that use water and discharge water or other pollutants into streams. Point sources can be found along many of the DEQ-listed rivers in the Flathead-Stillwater watershed, and all of them are permitted sources under the regulatory authority of the State of Montana. These point sources include:

- Wastewater Treatment Plants
- Small municipal separate storm sewer system (MS4) (storm water)
- Construction storm water
- Industrial storm water
- Montana Department of Transportation
- Stream-side subdivisions

Discharges permitted by the state for these entities can contribute nutrient, sediment, and temperature pollutants to the streams, as well as pathogens, so it is important to carefully manage activities and all permits enforced. As long as needed updates are made and permit standards are met, point source discharge should have little influence on overall stream impairments. Because of their careful regulation, point sources will not be addressed further in this plan.

3.7 Streams of Concern - Pollution Causes and Sources

To create a watershed-wide approach to NPS pollution restoration, it is imperative to include planning for DEQ-listed streams, as well as include non-listed streams that are of concern to local stakeholders and the community. FCD has decided to include these “streams of concern” in this WRP to outline projects currently being done by FCD and other watershed organizations. Our intent is that these streams can be managed proactively to avoid DEQ listing, and restoration of these streams will benefit any DEQ-listed streams they are connected to. A common pollutant in almost every listed stream is excess sediment due to streambank erosion, upland erosion, and unused forest roads. These sources are also present on many of the streams of concern. Other concerns for these streams include nutrient loading, increased water temperatures, and excessive flooding.

Section 4: Identifying Estimated Reductions and BMPs

4.1 Estimated Reductions in Sediment, Nutrient, and Temperature Loading

The sediment, nutrient, and temperature TMDLs estimate the amount of each pollutant that could be reduced by implementing appropriate best management practices (BMPs). These NPS pollution reduction goals are derived from the recommendations of the *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan* (DEQ, 2014b). Estimated nutrient, temperature, and sediment load reductions are included for each impaired waterbody (Tables 4, 5, and 6). **Note:** The loads and expected load reductions are estimates based on models which use average observed flows and temperatures.

Table 4. Estimate of nutrient load reductions from NPS pollution and natural backgrounds (lbs/day) expected by implementing nutrient-reducing BMPs for streams with nutrient TMDLs (DEQ, 2014b). Percent reduction from the current estimated load is shown in parentheses.

Waterbody	TMDL Nutrient Targets [a]	Average Current Nutrient Loads [a]	TN Estimated Reduction	TP Estimated Reduction
Upper Ashley Creek	TN: 12.40	TN: 17.13	4.73 (28%)	N/A
Middle Ashley Creek	TN: 22.14 TP: 2.01	TN: 67.63 TP: 2.42	45.49 (67%)	0.41 (17%)
Lower Ashely Creek [b]	TN: 20.20 TP: 1.84	TN: 230.60 TP: 4.41	210.4 (91%)	2.57 (58%)
Spring Creek	TN: 6.83 TP: 0.62	TN: 14.66 TP: 1.96	7.8 (53%)	1.34 (68%)

[a] See *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs* (DEQ, 2014b) document for TMDL and reduction calculations.
[b] The estimated load reductions for Lower Ashley Creek includes a Waste Load Allocation (WLA) from Kalispell wastewater treatment plant (WWTP). This WLA expresses the existing load and percent reduction of wastewater entering Ashley Creek and is based on modeled loading.

Table 5. Estimate of temperature load reductions from NPS pollution (kcal/s &°F) expected by implementing shade-increasing BMPs for streams with temperature TMDLs (DEQ, 2014b). Percent reduction from the current estimated load is shown in parentheses.

Waterbody	Allowable Temperature Load [a]	Existing Temperature Load[a]	Estimated Temperature Reduction
Upper Ashley Creek	2,633 / 65.5°	2,689 / 66.2°	56 / 0.7° (2%)
Middle Ashley Creek	2,575 / 67.6°	2,972 / 73.1°	397 / 5.5° (13%)
Lower Ashley Creek [b]	3,595 / 62.01°	6,746 / 68.61°	1,032 / 5.6° (15%)
Whitefish River [b]	82,127 / 69.58°	82,389 / 69.7°	1,086 / 0.7° (1%)

[a] See *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs* (DEQ, 2014b) document for TMDL and reduction calculations.
[b] The estimated load reduction for these two stream reaches include a WLA from municipalities who discharge water into the stream. This WLA expresses the existing load and percent reductions of wastewater entering Ashley Creek and is based on modeled loading.

Table 6. Estimate of sediment load reductions [a] from NPS pollution (tons/year) expected by implementing BMPs by source category and total for streams with sediment TMDLs (DEQ, 2014b). Percent reduction from the current estimated load is shown in parentheses. Allowable sediment loads take into consideration implementation of riparian BMPs.

Waterbody	Unpaved Roads			Streambank Erosion			Upland Erosion			Total Estimated Sediment Reduction
	Allowable Sediment Load	Current Sediment Load	Estimated Sediment Reduction	Allowable Sediment Load	Current Sediment Load	Estimated Sediment Reduction	Allowable Sediment Load	Current Sediment Load	Estimated Sediment Reduction	
Upper Ashley Creek	12.4	17.7	**5.3 (30%)**	114.8	255.2	**140.4 (55%)**	217.1	227.8	**10.7 (5%)**	**156.4 (31%)**
Middle Ashely Creek[b]	14.8	21.2	**5 (24%)**	277.5	533.7	**256.2 (48%)**	340.0	383.5	**43.5 (11%)**	**304.7 (32%)**
Lower Ashley Creek[c]	16.2	23.2	**7 (30%)**	388.1	736.8	**353.7 (48%)**	427.0	496.7	**69.7 (14%)**	**430.4 (34%)**
Coal Creek [d]	0.125	0.5	**0.375 (75%)**	0.01	0.1	**0.09 (90%)**	0	34	**34 (100%)**	**34.465 (99%)**
Haskill Creek	3.9	5.6	**1.7 (30%)**	346.3	372.4	**26.1 (7%)**	301.0	375.7	**74.7 (20%)**	**102.5 (14%)**
Logan Creek	23.3	29.8	**6.5 (22%)** [e]	2,264.5	2,264.5	**0 (0%)**	705.85	705.9	**0.05 (0.01%)**	**6.55 (0.2%)**
Sheppard Creek	6.2	7.1	**0.9 (13 %)** [e]	393.5	393.5	**0 (0%)**	146.4	146.4	**0 (0%)**	**0.9 (0.2%)**
Stillwater River	116.4	166.3	**49.9 (30%)**	12,240.6	12,240.6	**0 (0%)**	2,673.8	3,066.8	**393 (13%)**	**442.9 (3%)**

[a] See *Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs* (DEQ, 2014b) document for TMDL and reduction calculations.
[b] Sediment loading to the middle Ashely Creek segment from eroding streambanks consists of sediment from Upper Ashley Creek.
[c] The percent reduction for lower Ashley Creek for streambank erosion was based off of middle Ashely Creek since no bank erosion field data was collected.
[d] These load reductions are taken from the Flathead Headwaters TMDL completed in 2004 and the upland erosion estimates refer specifically to timber harvest activities.
[e] These estimated reductions were applied only to unpaved roads in those watersheds where the USFS has not recently implemented BMPs.

4.2 Best Management Practices (BMPs) for NPS Pollution Reduction

Achieving the load reductions outlined in the TMDL is highly dependent on the implementation of BMPs. BMPs are voluntary, pollution-prevention practices that focus on avoiding contact between pollutants and waterbodies (DEQ, 2014b). Many different types of BMPs can be implemented to reduce NPS pollution to a given water body (Figure 9). Increasing riparian vegetation is one of the most effective ways to reduce sediment, nutrients, and temperature. Riparian vegetation promotes natural stream functions by stabilizing streambanks, filtering excess nutrients and sediments, and providing shade to the stream (Figure 10). Other recommended BMPs for each pollutant from the 2012 Montana NPS Management Plan (DEQ, 2012) are identified in Appendix B.

BMPs can be separated into two categories: active and passive. Passive practices remove the source of the disturbance and allow natural succession to occur over a longer period of time. For example, installing riparian fencing can keep livestock out of a stream and allow the riparian vegetation to regenerate naturally. Active practices have more immediate impacts on water quality by accelerating natural processes or changing the direction of succession. These practices may include the use of heavy machinery to change the course of water flow or assist in mass plantings to accelerate vegetative cover in riparian areas (DEQ, 2014b). Passive practices are preferable to active because they are more cost effective, less labor intensive, and have negligible short-term impacts.

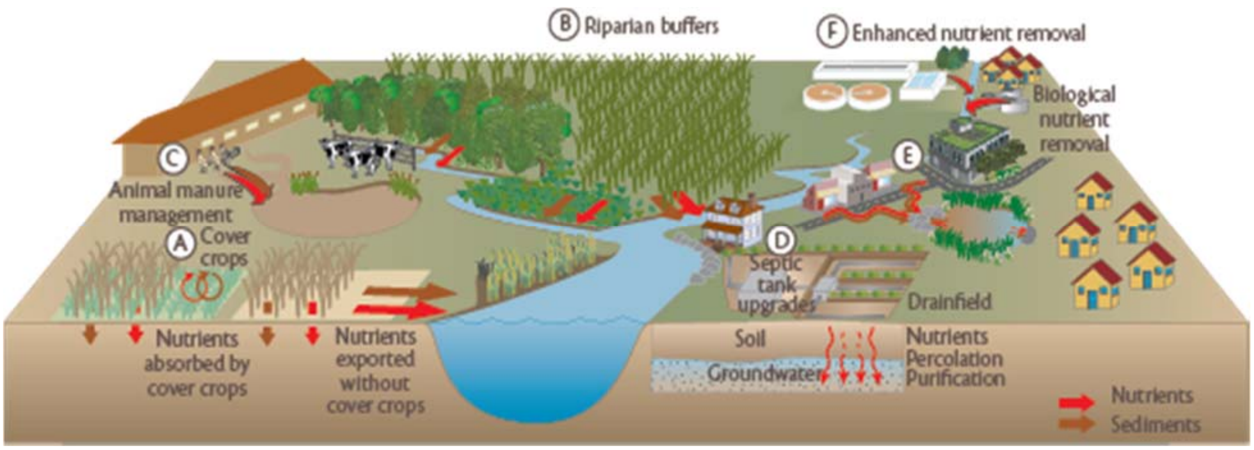

Figure 9. Examples of BMPs to be used across the watershed to promote NPS pollution reduction.
Source: http://ian.umces.edu

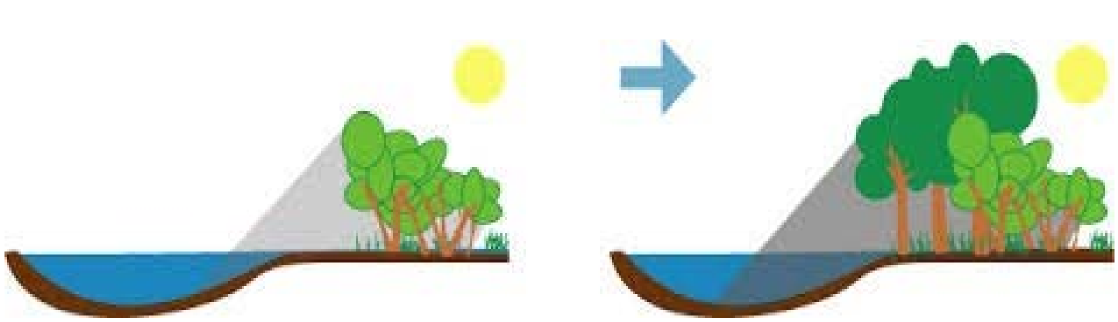

Figure 10. Riparian vegetation provides shade to the stream which helps keep temperatures cool.

4.3 Conservation Management Measures to Address Non-Listed Watershed Pollutants

4.3.1 Aquatic Invasive Species (AIS) Management Measures

AIS introductions have severe detrimental effects on both native aquatic ecosystems and local economies. Aquatic invasive plants can hinder recreational opportunities and reduce water quality. Invasive mussels can disrupt aquatic food webs, with ecological repercussions for many native aquatic organisms. They also hurt local economies because they tend to congregate in pipes for infrastructure, such as power plants or water treatment plants. In addition, invasive mussel infestations are linked to declines in tourism and property values. As of 2016, three aquatic invasive plant species have been identified in the Flathead watershed: flowering rush, curlyleaf pondweed, and fragrant waterlily (Figure 11). To date, invasive mussels have not been detected in the Flathead watershed, but zebra and quagga mussel larvae were identified in several locations in Montana late in 2016 (Figure 12). Preventing their

Aquatic Invasive Plant Locations in Montana - 2016

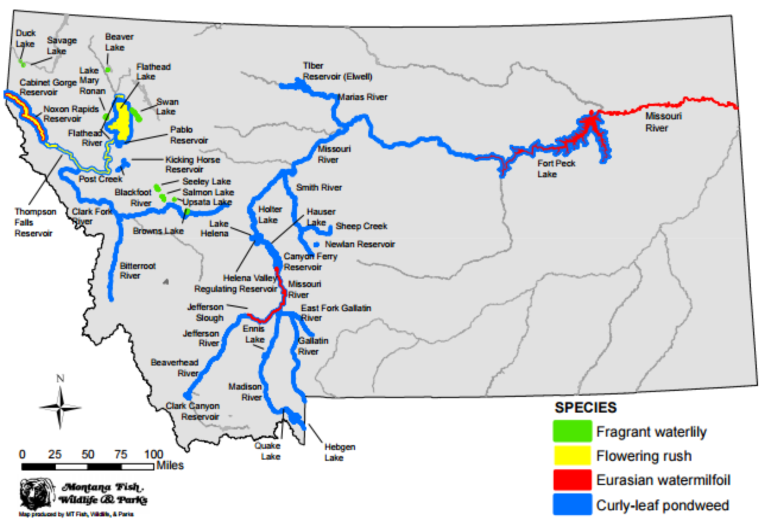

Figure 11. Current locations of AIS Plant Species as of 2016 (FWP).

Aquatic Invasive Mollusk Locations in Montana - 2016

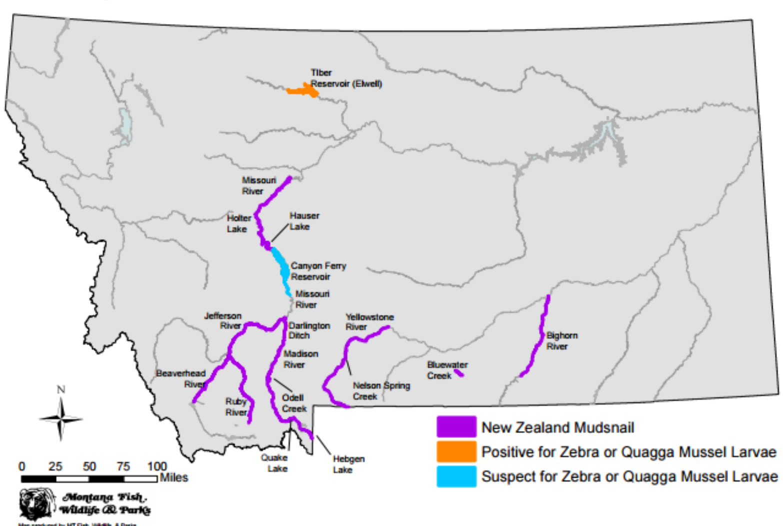

Figure 12. Current locations of AIS Mollusk Species as of 2016 (FWP).

spread to the western side of the state is critical to keeping them out of to the Columbia River Basin, which is one of the last major uncontaminated river systems in the West.

Several local groups work on AIS prevention and control in the Flathead watershed. In 2009, the Flathead Basin Commission convened the Flathead Basin AIS Work Group, which completed the Flathead Basin AIS Prevention Strategy in 2010 (FAISWG, 2010) and an update in 2016 (FAISWG, 2016). The goal of this plan is to help initiate and sustain local efforts as appropriate to prevent, control and/or eliminate AIS within the Flathead watershed. It outlines strategies and activities to help control the introduction and spread of AIS within the Flathead watershed (Appendix C).

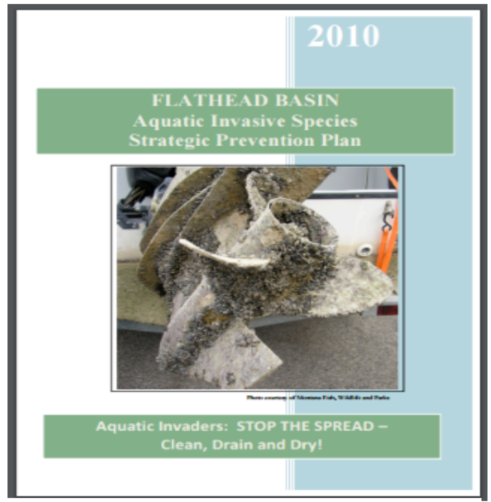

Figure 13. Cover of the Flathead Basin AIS Prevention Strategy 2010.

Another useful resource for identifying AIS management measures is the Flathead Lake Watershed Restoration Plan (Flathead Lakers, 2014). The Flathead Lake WRP identifies steps in AIS prevention, including resources required and assessment of success. Though it focuses on the Flathead Lake watershed, these measures are applicable to the entire Flathead-Stillwater watershed. The Lakers also provide information about AIS prevention and control on their website.

4.3.2 Wastewater Management

Septic systems serve as onsite wastewater disposal systems for homes and other buildings that are not connected to a city or county sewer system. Septic systems are designed to drain away human waste underground at a slow, harmless rate. However, an improperly designed, located, constructed, or maintained septic system can leak bacteria, viruses, household chemicals, pharmaceuticals, and nutrients into local groundwater or surface waters. More specifically, septic system failures can occur when wastewater either breaks out at the surface or seeps into the soils and travels to groundwater sources. In areas where both individual water wells and septic systems are used by landowners, there is a greater danger of drinking water contamination by septic system failure because of the relative proximity of the two systems. In areas where soils are sandy and less dense, there is potential that a septic failure will allow household wastewater (i.e., nutrients) to move quickly to groundwater sources. Some research also indicates that

Figure 14. Leaking septic system in a residential yard. Surface leaks such as this can runoff over surfaces and impair nearby waterbodies (www.hardwareandtools.com).

septic failure rates are highest in well-drained soils because of inadvertent undersizing of leach fields. In areas with clay soils, septic failures lead to runoff of pollutants to surface waters because the clay does not allow water to easily move through soil underground. In the Flathead watershed, with its high concentration of alluvial soils, groundwater contamination often results in the contamination of local lakes and rivers, as can be seen with the Flathead-Stillwater TMDL. See Appendix B for specific septic system maintenance BMPs.

Many local, state, and federal organizations can provide information on septic systems, including:

- Flathead City-Council Health Department/Environmental Health Department (http://flatheadhealth.org/environmental-health/sewage-and-septic) - information related to septic applications, permits, site evaluations, and on-site treatment system elements for both commercial and residential users.
- DEQ (www.deq.mt.gov/Land/solidwaste/pumpers) - regulations related to septic tank design, installation and maintenance, along with a list of certified septic tank pumpers.
- EPA (https://www.epa.gov/septic/septic-systems-guidance-policy-and-regulations) - guidance, policy, and regulations related to septic systems that govern DEQ requirements.
- Flathead Basin Commission (www.flatheadbasincommission.org) works with the Flathead Regional Wastewater Management Group to aid point source producers in developing innovative solutions to reduce nutrient loads.
- Flathead Lakers (www.flatheadlakers.org) - information on water quality monitoring and septic system maintenance. Free site visits to educate and work with landowners to reduce NPS pollution, including septic care and maintenance.
- Whitefish Lake Institute (http://www.whitefishlake.org/download/index.php#septicLake) - focuses much of their work on nutrient loading associated with septic systems and their impacts on Whitefish Lake.

In Flathead County, a number of private companies also provide septic tank pumping services for a reasonable cost. It is advisable to compare costs in advance of contracting for pumping services.

Additional resources and efforts are needed to address wastewater management and septic maintenance within the Flathead-Stillwater watershed, such as:

- The Carver Engineering Study, which was commissioned by the Flathead Regional Wastewater Management Group, provides a baseline for identifying areas most in need of septic system replacement. A prioritization and detailed fiscal analysis are needed to identify in more detail:
    - Areas that could be most readily connected to sewer systems, the cost, and the possible financing options;
    - Areas with pro-active homeowners associations that may wish to partner in septic maintenance/replacement programs;
    - In areas where transitioning from septic systems to sewers is possible, a land use planning assessment and recommendations to ensure that sewers do not lead to other nutrient loading problems (i.e., increased overland flow from increase in impervious services and increased stormwater runoff).
- A revolving loan program or similar grant program to replace oldest septic systems most likely to be leaking, especially in areas adjacent to surface water supplies, near drinking water wells, in shallow groundwater areas, and/or in critical wildlife habitat areas.

- Expanded educational efforts, such as the Flathead Lakers "Safeguarding Flathead Lake" program.
- Business community partnerships to foster environmental sustainability, including (but not limited to) septic maintenance. Partnerships could be modeled after the federal LEED program (http://www.usgbc.org/leed), which provides various levels of certification for the construction of sustainable buildings. However, this program would be managed at the local level to provide green certification to the Flathead businesses for sustainable management practices, such as regular pumping of septic tanks.
- A stewardship program for Flathead residents to encourage sustainable practices, such as the regular pumping of septic tanks. The program would have seminars on a variety of topics to reduce nutrient loading, including lawn care, septic maintenance, and/or use of pervious surface materials.

4.3.3 Protection of Healthy, Functioning Riparian Areas, Wetlands, and Floodplains

Another important conservation management measure in the Flathead-Stillwater watershed is the protection of the riparian areas, wetlands, and floodplains that are critical for wildlife habitat, groundwater recharge, reducing severity of floods, mitigating upland and streambank erosion, and filtering pollutants from runoff. The multiple ecological and aesthetic values of these lands, coupled with concerns about rapid growth and development in the Flathead, led to the initiation of the Critical Lands Project in 2000 by the Flathead Lakers. The project brings together resource managers, conservationists, and scientists to explore opportunities for collaboration on projects that address the common goal of protecting the land and water that is critical to maintaining the quality of Flathead Lake and its surrounding watershed (von der Pahlen, 2004).

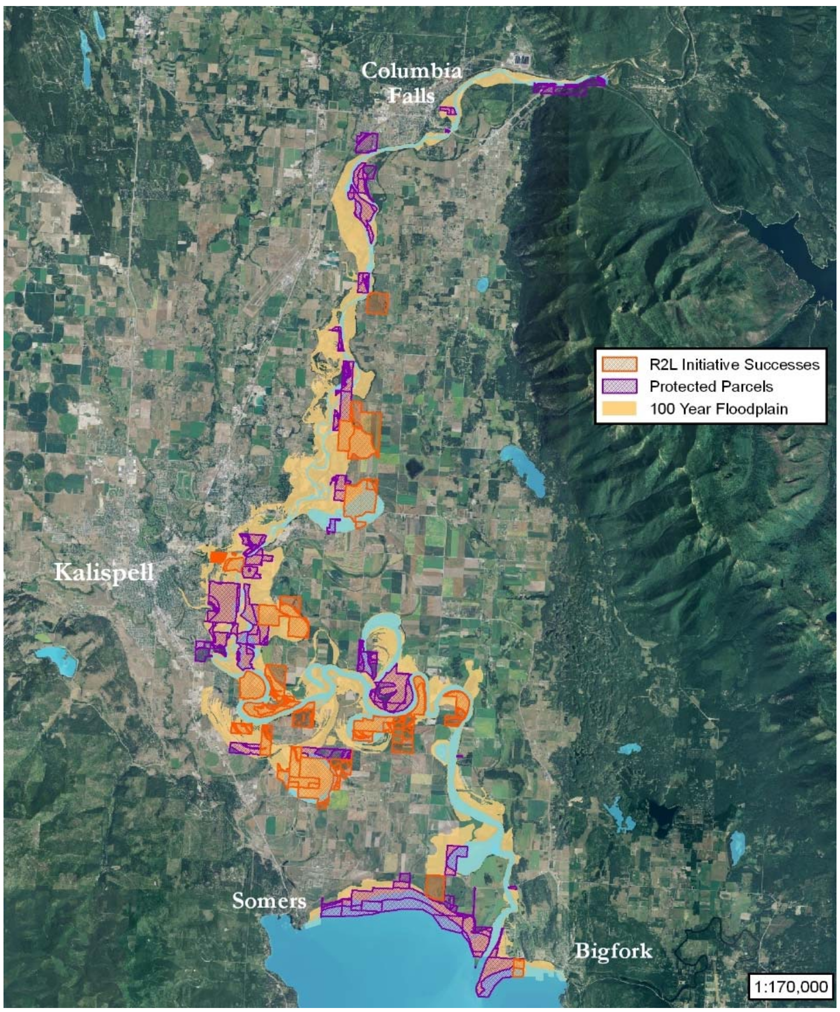

Figure 15. River to Lake Initiative map of critical lands protected.

The focus area of the Critical Lands Project includes the Flathead Valley above Flathead Lake (including the entire Flathead-Stillwater watershed) because it contributes the highest nutrient loads to the lake and is facing significant growth pressures. The priority lands for protection include wetlands, vegetated stream banks, floodplains, shallow groundwater areas, and associated farm lands. Conservation of these lands helps to maintain water quality in the Flathead watershed, but it also protects wildlife habitat, recreation opportunities, and scenic beauty.

More recently, the Critical Lands Project developed the River to Lake Initiative (R2L), which focuses conservation efforts on the mainstem Flathead River corridor from Columbia Falls to Flathead Lake, including the lake's north shore (Figure 15). Together, the Critical Lands Project and R2L partners have conserved over 6,000 acres of critical lands along the Flathead River and the lake's northern shore and have restored over three miles of Flathead River riparian areas. Much of the land protection has occurred through conservation easements, which include restrictions on future development and a comprehensive management agreement. The on-the-ground riparian restoration projects were facilitated through the Flathead River Steward Program, which is a smaller partnership of R2L partners (Flathead Lakers, FWP, NRCS, and FCD) that works with landowners to enhance riparian areas. The River Steward is typically a member of the Montana Big Sky Watershed Corps who serves an 11-month term. The River Steward coordinates restoration planting projects, conducts project effectiveness monitoring, and assists with landowner education and outreach.

4.3.4 Noxious Weed Management

Terrestrial noxious weeds out-compete native plants, alter ecosystems, and destroy natural habitats. They typically do not have well-developed root systems, so their proliferation in riparian areas reduces bank stability and accelerates erosion. Noxious weed management requires an integrated approach to be successful.

Prevention is the first line of defense in keeping weeds from occurring or increasing in an area. Prevention tactics include:

- Ensure equipment and vehicles are clean and free of visible debris before entering a weed free zone.
- Minimize ground disturbance on all lands, as disturbed areas are susceptible to weed encroachment.
- Re-vegetate with native species as needed immediately following disturbance.

Control measures reduce a weed population to a level where land can be utilized to its fullest potential and can prevent future infestations. There are four different control measures:

- **Chemical** - use of herbicides (applications require a National Pollutant Discharge Elimination System (NPDES) discharge permit (MTG870000) from DEQ for pesticide application to or over surface water).
- **Cultural** - cultivate a desirable plant to compete with the noxious weed.
- **Mechanical** - physically disrupting weed growth by hand pulling, mowing and burning.
- **Biological** - living organisms disrupt weed growth using a natural insect enemy of the plant.

Eradication is the end goal for many landowners and weed managers, but is difficult to achieve. The key to eradication is early detection of the noxious weed before it can spread. Weed identification and determination of potential weed priority areas allows landowners to get a head start on weed management.

Noxious weed management requires cooperation between adjacent landowners, especially to coordinate early detection efforts and control measures. Landowners can reduce costs by compiling resources (e.g., purchasing an herbicide to share, mapping weed distribution, or sharing rental equipment, such as backpack sprayers). The Flathead County Weed District is available to meet with landowners and conduct site visits to discuss and answer questions about weed management plans, plant identification and control options. The Flathead County Weed District can be reached at 406-758-5798 or visit their website: www.flathead.mt.gov/weeds/.

4.3.5 Channel Migration

Stream or river channel migration is a natural geomorphic process that results from constant reworking of sediment by the water. Evidence of the historical migration of the Flathead River and its tributaries can be easily viewed through aerial photos, wherein the numerous sloughs and oxbow lakes that make up the Flathead Valley landscape are readily apparent. Sediment is eroded from banks and is either transported downstream or deposited in new areas to build point bars. Migrations can be problematic when they threaten structures and erode private property. Channel migration mapping allows communities to understand the potential migration paths of stream channels and identify areas in need of protection for future migrations.

The Flathead Lakers worked with Applied Geomorphology Inc. (AGI) and DTM Consulting, Inc. to develop a Channel Migration Zone (CMZ) analysis for 24 miles of the mainstem Flathead River from the bridge at Highway 35 downstream to where the river flows into Flathead Lake. CMZ mapping identifies the corridor area that the stream channel, or series of stream channels, can be expected to occupy over a given timeframe. The intent of the Flathead River CMZ mapping is to identify areas prone to channel migration over the next 100 years (Boyd et. al., 2010). The Flathead Lakers have identified the need to continue this mapping process further upstream to include the entire mainstem Flathead River. Potential applications for the CMZ maps include:

- Identify restoration opportunities where bank armor has restricted the natural CMZ.
- Provide background tool to assess channel dynamics within any given area.
- Assist in development of river corridor best management practices.
- Improve stakeholder understanding of stream behavior.
- Identify areas where channel migration easements would be appropriate.
- Inform future planning and decision making for residential and urban development.

Section 5: Identifying Technical and Financial Assistance Needs

5.1 Technical Partners

Successfully mitigating NPS pollution requires collaborations among many different organizations and people. There are many organizations that can provide leadership and assistance in planning projects, implementing projects, and conducting public education and outreach about NPS pollution.

FCD consists of a board of supervisors who represent the broader Flathead community. Their expertise often guides FCD's activities and priorities, and backgrounds include agriculture, law, forestry, science, and education. Members of the board also lend their expertise to related organizations or activities, such as Flathead River Commission, Haskill Basin Watershed Council, Clark Force Basin Council, Flathead Basin Commission, Montana Association of Conservation Districts, Whitefish City Planning Board, and Flathead County Planning Board.

FCD relies on many technical partners for input on project development, implementation, and monitoring, including those listed in Table 1. Other partners include:

- Confederated Salish and Kootenai Tribes
- Flathead Lake Biological Station
- Montana Association of Conservation Districts
- Montana Conservation Corps
- Montana Watershed Coordination Council
- Soil and Water Conservation Districts of Montana
- United States Army Corps of Engineers

In addition to local organizations, FCD works with landowners on projects to enhance and sustain their land and water resources. A large percentage of the listed impaired streams in this watershed are located on privately-owned land, which means support and participation of local landowners are vital to successfully implementing restoration projects and reducing NPS pollution.

Local community volunteers are key to many successful restoration projects. Volunteers provide cost-effective labor and, in return, they receive a hands-on educational experience. Local groups that may be interested in volunteering for stream restoration projects include:

- High school clubs (e.g., Whitefish High School – Project FREEFLOW)
- College organizations (ex. Flathead Valley Community College, Montana State University, University of Montana)
- Montana Conservation Corps crews
- Flathead Community of Resource Educators (CORE)
- Local conservation-focused community groups (Flathead Chapter of Montana Audubon, Women in Timber, Trout Unlimited)

Water quality improvement projects are often complex and require professional technical assistance. Many engineering and watershed consulting firms can provide assessments, designs, and implementation oversight. FCD can provide guidance on engaging these professional groups.

5.3 Financial Assistance

Each restoration project is different, and, thus, each requires a unique approach to funding. Many projects draw on multiple sources of funding from inception to completion. There are several government agencies and non-government organizations that can fund or provide assistance (e.g., grants) for watershed or water quality improvement projects. Note that some of these funding sources and programs may be discontinued in the future, and new sources of funding could become available. The Montana Watershed Coordination Council (MWCC) provide an overview of various funding sources for water quality projects throughout Montana on their website (www.mtwatersheds.org).

Locally, FCD provides funding for private landowners to complete small-scale conservation projects, such as riparian fencing, plantings, or forest thinning. FCD also has grants for educators to support natural resource education. Local funding can also be sought from a variety of agencies or private businesses, including the FNF - Flathead County Resource Advisory Committee.

Project costs can vary from a few thousand to several hundred thousand dollars depending on the scope, activities, and level of degradation (Table 8), and the broad scope of this WRP precludes us from outlining exhaustive details about budgets and possible funding sources for each individual project. Estimates of many conservation activities, including fencing and riparian planting, can be found in NRCS Technical Guide Section I (used for EQIP). These costs are updated annually by an economist, but they are intended to be used across a large, multi-state region, so users should anticipate variability. For example, the cost estimate provided for fencing (smooth wire, 3-5 wire, including installation) in 2017 was $1.26/ft, but actual estimates from a local contractor were close to $5.00/ft. Table 7 provides some local examples of project costs, but project leaders should expect additional expenses and time expenditures, such as herbicide, tools, watering, fence maintenance, soil amendments, and permitting.

Table 6.A. Potential project costs based on local contractor estimates in the Flathead Valley.

Activity	Estimated cost
Riparian fencing – 5 strands, smooth wire, including installation	$5.00/ft
Hardened crossing	$3,000/ea
Culvert replacement (no engineering; includes permitting)	$5,000/ea
Coir logs (10 ft long)	$188/ea
Containerized woody vegetation	$7.00/shrub; $9.00 tree
Rigid seedling protection tubes	$0.55/ea
Weed mat – 3’x3’	$0.75/ea

Section 6: Information and Education Opportunities

Landowner and community outreach are key to sustaining an ongoing watershed restoration program. Public educational programs and events are good avenues to teach people about NPS pollution, and they can also build community support, which can lead to volunteers, financial contributions, and/or technical support. Moreover, educating waterfront landowners about restoration activities can help them go from feeling overwhelmed by problem on their property to taking restorative action.

FCD and its partner organizations promote natural resources conservation education, outreach and on-the-ground projects through events and programs. Below are some examples of how FCD and partners conduct public education and outreach.

Figure 15.A. Examples of educational activities. Forestry Expo Riparian Station (upper) and Rolling Rivers Trailer (lower).

- **FCD Cost-Share Program**: Financial assistance to private landowners implement conservation projects in Flathead County. This program funds 75% of the project (up to $5,000).
- **FCD Education Grants**: Financial assistance for Flathead County educators to purchase equipment and/or supplies for natural resource education.
- **Family Forestry Expo**: Held annually in May, this event is sponsored and put on by a large group of local agencies and organizations. During the week, 5th graders from around the Valley have an opportunity to learn about forest, land, and water management. The public is invited on Saturday for a variety of hands-on activities and demonstrations. www.familyforestryexpo.org.
- **FCD Website**: Provides information about FCD programs, the 310 law, and conservation projects completed, as well as a variety of landowner resources about BMPs, NPS pollution, and other soil and water conservation information. www.flatheadcd.org.
- **Flathead Community of Resource Educators (CORE)**: A network of individuals and organizations who work to raise awareness and understanding of the natural, historical and cultural resources of the Flathead region. CORE is open to all resource educators and professionals and it provides practical tools, training and materials for educators and promote the diversity of ideas and cooperation to support a greater understanding of the place we live. http://flatheadcore.org/.
- **Flathead Watershed Sourcebook and Educators' Guide**: *The Flathead Watershed Sourcebook: A Guide to an Extraordinary Place* (www.flatheadwatershed.org) is a bio-regional text that spans natural history, geography, culture, and economics of the Flathead watershed. The book was completed in 2010 (2nd edition 2017) by Lori Curtis with support from Flathead CORE. An companion text, the *Flathead Watershed Educators' Guide*, was developed as a complementary resource for middle school teachers. Broad dissemination of the guide began in 2016.
- **Montana Lake Book**: This publication, led by WLI and FWP, summarizes how lakes function, as well as threats to Montana lakes, and simple actions people can do to protect lakes. The 3rd edition will be printed in 2017 and will include new and updated information.

- **Newspaper Ads**: FCD advertises in the Flathead Beacon and other publications to promote programs, 310 law, and special events.
- **River to Lake Initiative (R2L):** R2L is a collaborative effort to conserve, enhance, and maintain the natural heritage and ecology of the Flathead River and Flathead Lake. R2L is a broad partnership of agencies, non-profits, and individuals who work together to conserve land, share information, and implement restoration projects. http://www.flatheadrivertolake.org/.
- **Rolling Rivers Trailer**: A mobile teaching unit demonstrating a variety of water lessons including: river energy, riparian areas, NPS pollution, water diversions, and development along shorelines. Trailer presentations can be tailored to many different ages. FCD can loan the trailer to other CDs or non-profits under a lease agreement.
- **Seedling Program**: Partnership between FCD and the DNRC Montana Conservation Seedling Nursery to facilitate conservation-related seedling orders for small landowners in Flathead County. Program is open to landowners with ≤ 10 acres who wish to plant seedlings for conservation practices but cannot meet the Nursery's minimum order of 250 seedlings.

Further outreach and educational events may also be conducted through the following activities:

General Community Outreach

- Post information and resources on FCD website and collaborate with other organizations to produce and distribute educational materials.
- Create informational literature about NPS pollution to distribute to landowners and community members through mail or as a handout during FCD events.
- Place periodic watershed health articles and FCD ads in community newspapers (Flathead Beacon, Daily Interlake).
- Host tours for target groups, as well as members of the general public, showcasing completed projects. Multiple agency and organization partners should take part in these tours to demonstrate the effectiveness of collaboration in improving water quality and quantity.
- Arrange site visits to waterfront property landowners who request information on NPS pollution and BMPs.
- Collaborate with local organizations to host public meetings and workshops.
- Host community meetings and conduct surveys for specific basins and stream reaches to engage local landowners in identifying issues and potential solutions and/or barriers to action. Use this information to prioritize restoration projects.

Youth Education

- Engage local youth in volunteer water monitoring or restoration projects.
- Engage school clubs and organizations in volunteer projects and events.
- Create new educational workshops to engage youth in NPS pollution awareness and projects.
- Continue current FCD educational events, including Family Forestry Expo and Rolling Rivers Trailer presentations. Collaborate with schools to identify new educational opportunities.
- Work with local teachers to help incorporate NPS pollution education into curricula through FCD education grants and the educator workshops.
- Work with Flathead Lakers to implement findings from the *Recommendations for Implementing K-12 Riparian Buffer and BMPs Education in the Flathead Watershed* report.

Section 7: Identifying and Implementing Restoration Projects

7.1 Implementation Plan

Before initiation of new restoration projects on streams identified in this WRP, FCD and accompanying partners will follow a general implementation plan (Figure 16). This plan identifies five major steps and outlines the process of identifying and implementing restoration and conservation techniques for any waterbody in the Flathead-Stillwater watershed.

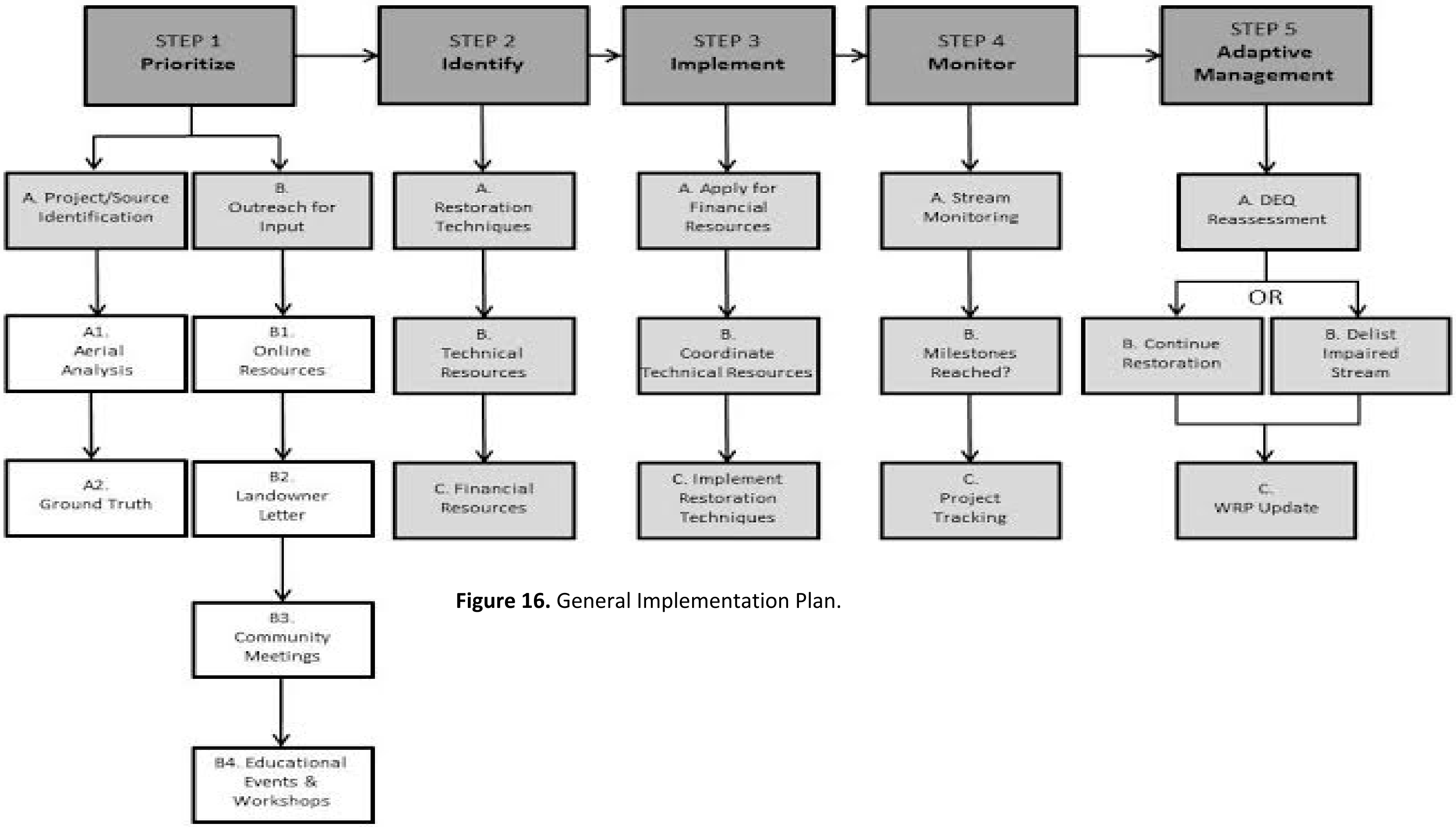

Figure 16. General Implementation Plan.

The implementation plan outlines specific steps to complete a restoration project, with the ultimate goal of either delisting impaired streams or achieving restoration goals for streams of concern (to be identified for specific projects). Step 2 lists the resources needed to be identified before initiating a project. Step 3 lays out steps for implementing projects (Appendix H contains potential restoration techniques). Step 4 identifies the need for stream monitoring to identify reached goals (milestones) and project tracking. Step 5 lists adaptive management steps for adjusting goals and updating the WRP as needed. WRP updates will occur every 5 years or sooner if necessary.

An aerial analysis using Google Earth was conducted to identify potential project sites on the Flathead River (34 sites), Whitefish River (27 sites), Stillwater River (41 sites), Ashley Creek (64 sites), and the lower Swan River (15 sites). Sites were identified based on visual observations of erosion and plant community. Appendix D contains an example of this analysis. Potential project sites need to be ground-truthed and assessed before initiating landowner outreach.

Outreach to landowners will guide the identification of potential projects. Online resources will be bolstered to include NPS pollution and the services provided on the FCD website (www.flatheadcd.org). Local interest will also be built by holding community meetings in targeted areas (i.e., areas impaired streams), which will provide opportunities to educate the public about impairment listings and solicit their input. Appendices E and F contain a sample landowner letter and community meeting agenda. Projects will be prioritized based on community input and established criteria (Table 7).

Table 8. Criteria for project prioritization.

Aquatic Habitat	Could native trout habitat or habitats of other sensitive species benefit from a restoration project?
Landowner Support	Are landowners interested? Does the project address community/landowner concerns as well as water quality concerns? Are landowners willing and able to commit to a long-term restoration project?
Partnerships	Could multiple public and private partners involved? Who else could be involved?
Project Readiness	Is funding available or could it be secured? Have any environmental assessments completed? Are technical resources available?
Stream and Watershed Improvement Potential	Does the project: have potential to provide widespread/downstream benefits? Promote natural stream processes? Address other watershed priorities? Have a high prospect for success? Can it be replicated? Does it provide educational and outreach opportunities?
Threats	Are there any imminent/ongoing threats to water quality and habitat value other than NPS pollution?
Water Quality	Has an impairment been identified?
WRP Implementation	Is this project the most appropriate next step for making progress towards the removal of a pollutant?

7.2 NPS Management Problems, Project Histories, and Recommended Solutions by Stream

7.2.1 Ashley Creek

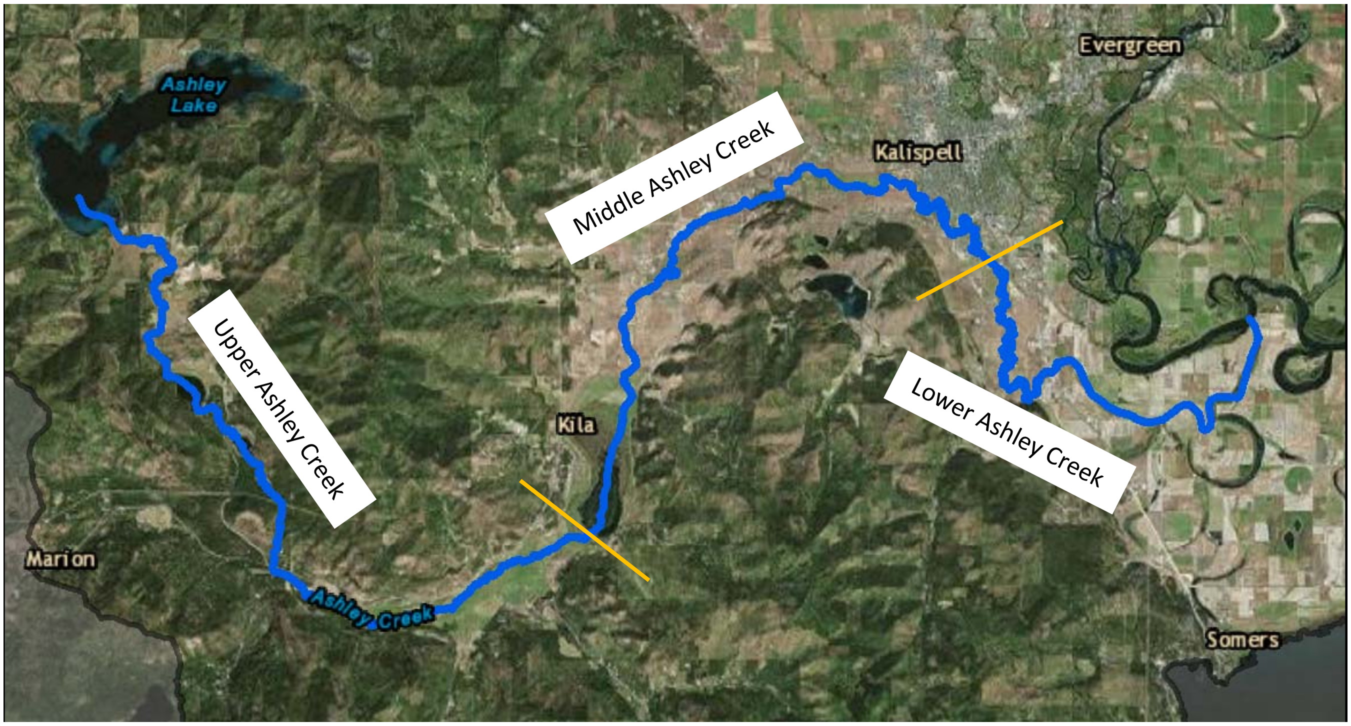

Figure 17. Ashley Creek with three separate segments. Upper Ashely Creek (Ashley Lake to Smith Lake), middle Ashley Creek (Smith Lake to Kalispell Airport Road), and lower Ashley Creek (Kalispell Airport Road to mouth (Flathead River)).

Ashley Creek originates at Ashley Lake and flows east for approximately 43 miles to its confluence with the Flathead River, south of Kalispell. DEQ divided it into three segments (Figure 17), and each has separate TMDLs and impairment listings.

- **Upper Ashley Creek** (Ashley Lake to Smith Lake) flows through a patchwork of grazed agricultural meadows and forested land. Land ownership along Upper Ashley Creek is mostly private (Weyerhaeuser is the largest private landowner), but some land is held by USFS.
- **Middle Ashley Creek** (Smith Lake to the Kalispell Airport Road) flows through agricultural land that transitions to residential as it approaches Kalispell. Land ownership along this segment is mostly private, but some is held by FWP.
- **Lower Ashley Creek** (Kalispell Airport Road to the Flathead River) flows through high densities of urbanization in Kalispell, as well as agricultural lands between Kalispell and Flathead Lake.

The flow of Ashley Creek is controlled by a slide gate dam at the outflow of Ashley Lake, which was constructed in 1928 to provide irrigation storage for downstream users, and it is managed by FWP. The fish population of Ashley Creek includes 8 native species (cutthroat trout, largescale sucker, mountain whitefish, northern pike minnow, peamouth, redside shiner, sculpin, and slimy sculpin) and 5 introduced species (brook trout, northern pike, rainbow trout, westlope-rainbow hybrids, and yellow perch). Non-native species currently dominate the creek, and only two isolated resident populations of cutthroat trout remain (DEQ, 2014b).

The Problem

DEQ listed all three segments of Ashley Creek for sediment, nutrient, and temperature impairments, with the exception of Upper Ashley Creek, which is listed for sediment, temperature, and only one of the nutrients, total nitrogen. This stream also suffers from a number of non-pollutant impairments, including alteration in stream-side covers, chlorophyll-a, and low flow alterations, all of which affect the pollutant loads throughout the creek. Nutrient loading occurs from croplands, livestock, and septic systems. Sediment loading occurs from eroding streambanks due to loss of riparian vegetation, erosion from unpaved roads, and residential/urban development. High water temperatures occur due to lack of shade from riparian vegetation and irrigation altering in-stream flow rates. These pollutant contributions limit the ability or fish and other aquatic life to survive and negatively affects the safety of recreational activities.

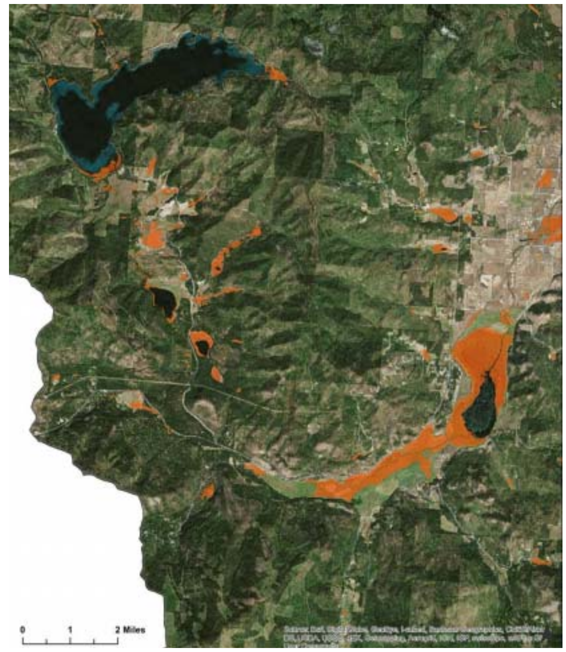

Figure 18. Wetlands along Ashely Creek.

Though the nutrient TMDL was completed in 2014, existing water quality data for upper and middle Ashley Creek show a large, unexplained nutrient load somewhere between Ashley Lake and immediately downstream of Smith Lake (Figure 20). This unexplained load is referred to as the “wetland complex” load, and it is thought to be related to the large wetland complex and unique soils. DEQ conducted flow measurements and water sampling throughout 2015-16 to investigate the source of the unexplained nutrient load. These data will help refine the nutrient model and provide better overall loading estimates to Flathead Lake. This information will also help local stakeholders and agencies prioritize projects to address nutrient loads.

What’s been done?

Private landowners, DNRC, Weyerhaeuser, Flathead National Forest, and local watershed organizations (Flathead Lakers and the R2L) have implemented various BMPs to address sediment loading from unpaved roads, timber harvesting activities, and agricultural activities.


Figure 19. Livestock fence installed along the ½ mile stream property to keep cows and other livestock out of the riparian area.

The River Steward program partners are exploring opportunities to collaborate with landowners on Ashley Creek. A recent project on lower Ashley restored about ½ mile of riparian forest. A wildlife-friendly fence was installed to create a 30-40-foot-wide buffer to prevent trampling of the creek banks and deer browse (Figure 19). Native trees and shrubs were planted inside the exclosure (Figures 20 and 21), and a water gap was installed to control livestock access. This project is expected to result in several tons of sediment reduction per year, several pounds of nutrient reductions per year, and a temperature reduction of up to 1°F.

Figure 20. Volunteers planting willow stakes into the ground with water jet stinger.

Figure 21. Small fenced area with bark mulch that provides weed protection and green tubes to eliminate vole damage.

Recommended Solutions

R2L and the River Steward partners plan to continue working on Ashley Creek through landowner collaborations. In 2016, they held their annual restoration tour at the project site on Ashley Creek and invited local landowners, five of which attended and expressed interest in future restoration efforts. Future work will build on this success using direct outreach and community meetings. Appendix G contains a map of Ashley Creek with riparian cover types (identified by DEQ), which may be helpful in identifying revegetation needs.

General BMPs that should be implemented along Ashley Creek include:

- Protect existing riparian forests.
- Manage livestock away from the creek and apply fertilizers and pesticides sparingly.
- Plant shrubs and trees in riparian areas.
- Build structures on upland areas.
- Maintain septic systems.

In addition, there is a wide network of unpaved roads within the Ashley Creek watershed. The following BMPs are suggested for reducing sediment from unpaved roads:

- Minimizing the number of roads constructed in the watershed.
- Fit road to topography and avoid long, step road grades and narrow canyons.
- Design roads to minimize disruption of natural drainage patterns.
- Install and properly maintain culverts.
- Maintain erosion control features including cleaning dips and cross drains, repairing ditches, marking culvert inlets, and clearing debris from culverts.
- Leave abandoned roads in a condition that provides adequate drainage without further maintenance. Actions may include: reseeding and/or scarification, re-contouring, and installing water bars or drain dips.

Timber harvesting also occurs extensively within the Ashley Creek watershed. These BMPs will reduce NPS pollution related to timber harvest activities:

- Use logging systems that best fit the topography, soil type, and season, and minimize soil disturbance.
- Avoid harvesting near stream banks.

7.2.2 Coal Creek

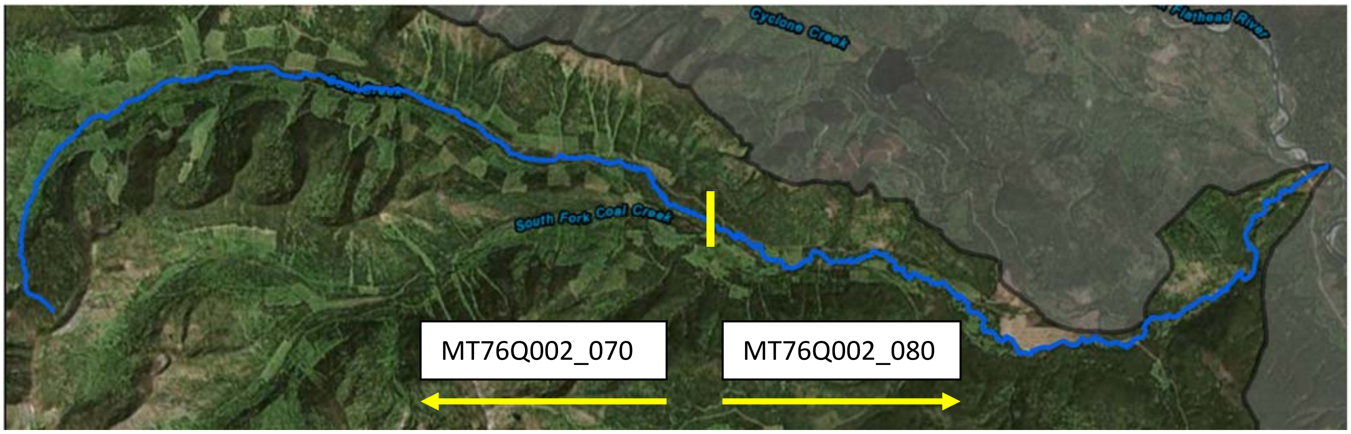

Figure 22. Coal Creek divided into two assessment units

Coal Creek is part of the North Fork Flathead River watershed. It was part of the *Flathead Headwaters TMDL* (DEQ, 2004b), but it is included in this document because of ongoing sedimentation issues. Coal Creek's headwaters are located in the Whitefish Range, and it flows east for 18 miles to its confluence with the North Fork Flathead River. Most of the landownership is USFS and DNRC, but small amounts are privately-held. Coal Creek is important bull trout spawning habitat.

The Problem

Coal Creek is divided into two assessment units (Figure 22). One flows from the headwaters to the South Fork of Coal Creek (MT76Q002_070) and has an impairment caused by alterations in streamside vegetation. The second flows from the South Fork of Coal Creek to its confluence with the North Fork Flathead (MT76Q002_080) and is impaired for sediment. The main sources of sedimentation and streamside vegetation alterations are timber harvest, unpaved road erosion, fire activity, and natural erosion. FNF found that several roads in the Coal Creek watershed have plugged culverts, sediment slumps, and actively eroding surfaces (DEQ, 2004b). The TMDL calls for a 99% reduction in sediment, amounting to 34.465 tons per year from anthropogenic sources. The majority of this sediment (34 tons/year) is attributed to upland sources from historical and current timber harvest practices (DEQ, 2004b).

In 2008, Traci Sylte and Amy Beussink prepared a Coal Creek Fluvial Geomorphic Trend Assessment for the FNF. They concluded that excess sediment in Coal Creek was derived from historic timber harvest activities as well as natural sources. Coal Creek and its tributaries are naturally influenced by steep terrain and glacial till (Figure 23). This causes the natural sedimentation rates to be much higher than a stream with lower gradients and different soils. Coal Creek is a very dynamic watershed with relatively long stream lengths that are limited in sediment capacity, and, thus, it is very sensitive to sediment input (Sylte, 2008).

The total area harvested in the Coal Creek watershed was approximately 7,475 acres since the 1950s (about 14% of the watershed area), and most of the roads in the watershed were built around that time for the timber industry (Sylte, 2008). Timber harvest can influence stream function in a number of ways, including:

- Loss of rooting strength and surface protection along stream banks, leading to increased streambank erosion and sediment loading.
- Loss of shade, resulting in increased stream temperatures.
- Reduction in sediment buffering capacity and habitat loss.
- Tractor harvesting causes soil compaction, reduced productivity, and reduced infiltration, resulting in potential for water routing and erosion, soil detachment, and loss of ground cover.
- Forest roads built for timber harvest access can produce large amounts of sediment loading to streams if proper BMPs aren't implemented or maintained over time.

The excess sediment entering the Coal Creek system, either from natural or anthropogenic sources, can affect aquatic life within the creek. Coal Creek is important bull trout habitat, and bull trout populations have declined in recent years, despite this suitable habitat (DEQ, 2004b). This suggests that excessive sediment contributions (either natural or anthropogenic) may be limiting fishery habitat in Coal Creek.

Wildfire is one of the natural drivers of sediment contributions to Coal Creek. In 2001, the Moose Fire burned 14,938 acres of the lower watershed, including portions of the Coal Creek mainstem riparian zone (Figure 24). The riparian shrub community was not substantially altered and continues to act as a stabilizing force to the stream banks, though the majority of trees for approximately two miles along the riparian corridor were killed. Over time, these trees fell into the stream, forming debris jams and bank stress, which potentially increased erosion. The 2006 Sundog Fire burned approximately 1,570 acres on South Fork Coal Creek (Sylte, 2008).

Figure 23. Common stream bank condition in Coal Creek (Sylte, 2008).

Figure 24. Riparian zone burn from the Moose Fire (2001) in Lower Coal Creek (Sylte, 2008).

What's been done?

Coal Creek was included in the USFS FNF's 2016 Draft Revised Forest Plan. The proposed forest-wide direction within this plan identifies the desired conditions, objectives, standards, and guidelines necessary for different physical and biological ecosystems. Under aquatic ecosystems, the Plan identifies the need to address sediment issues as determined by DEQ, and it identifies TMDL implementation needs in the Watershed Condition Framework and Conservation Watershed Network (USFS, 2016). In addition, the lower segment of Coal Creek (within the Coal Creek State Forest) is included in the DNRC Forested State Trust Lands Habitat Conservation Plan (HCP). This HCP lays out DNRC's intentions for conducting forest management activities while conserving habitat for grizzly bear, Canada lynx, and bull trout (listed as threatened under the Endangered Species Act) and for westslope cutthroat trout and Columbia redband trout. Specifically, for aquatic species, the HCP commits to manage and maintain suitable stream temperatures, in-stream sedimentation levels, in-stream habitat complexity, and stream channel stability and channel form and function within the HCP project area. DNRC also partnered with FWP and Bonneville Power Administration co-management group in 2015-2016 to mitigate substantial ongoing and foreseeable adverse impacts to native fish habitats at four existing road-stream crossing sites. This project (the Coal Creek Native Fish Conservation Project) will remediate three existing culvert sites and one existing bridge site on fish-bearing streams in the Coal Creek State Forest.

A significant number of roads have been decommissioned by the USFS in the Coal Creek watershed since the TMDL was completed in 2004 (Figure 25). Of the existing 125.3 miles of roads in the watershed, 29.31 miles were decommissioned between 1995 and 2016. Additionally, 54 miles of roads met USFS BMP standards by 2016. Of the remaining roads, 13 miles are no longer maintained for vehicles and almost 40 miles are closed (Personal communication, Nate Dieterich, USFS, 8/1/2016).

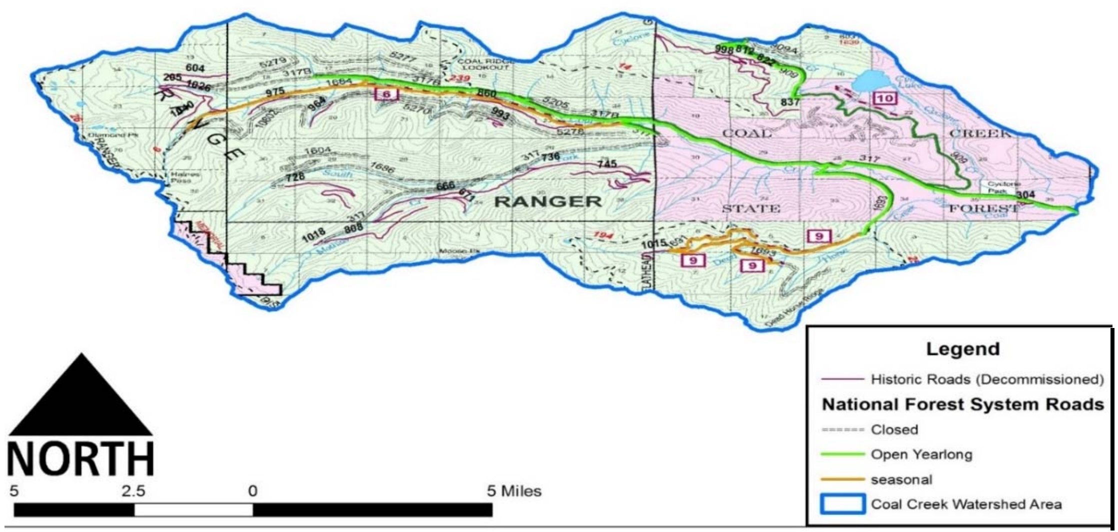

Figure 25. Coal Creek existing travel infrastructure (2016).

Recommended Solutions

FCD will continue to work with USFS and DNRC to monitor progress on road decommissioning and BMP implementation to address sediment. Once BMPs are in place, it may take significant time for the stream to meet established sediment water quality targets. It is important for stakeholders (USFS, DNRC, FWP, and DEQ) to collaboratively monitor instream habitat and water quality improvements.

The following BMPs should be implemented to reduce sediment loads:

- Decommission and decompact unused forest and skid roads.
- Narrow roads to standard engineering design widths wherever possible.
- Road-stream crossing structures should accommodate high bedload and debris scenarios and consider accommodating 500-year flood magnitudes to maximize structure life, minimize maintenance and optimize safety.
- Remove trapped sediment behind logjams in locations where increases in flood frequency are compromising infrastructures.
- Future timber harvest activities should provide a minimum of 200-300 foot buffers beyond channel migration zones for all stream types.
- Establish no harvest buffer and requirement for more tree retention, especially along streams supporting HCP fish species.
- Establish wider riparian management zones with no-harvest buffers for active channel migration zones.
- Implement greater monitoring and adaptive management provisions for grazing problems (DNRC HCP).

7.2.3 Flathead River

The main stem of the Flathead River flows from Hungry Horse Reservoir south to Flathead Lake. The majority of land in the lower 22 miles (priority segment of Flathead River) is privately-owned and has a long history of agriculture. There are 10 different public access locations along the Flathead River between Columbia Falls and Flathead Lake, and they are heavily used for boating, swimming, fishing, and wildlife observation. The Flathead River provides excellent habitat for many different aquatic organisms, as well as critical nesting and migratory stopover areas for thousands of waterfowl. The sediments deposited by the river during the time of the glaciers created some of the richest soils in Montana, supporting much of the Flathead's farming industry. Evidence of flooding events along the Flathead River can be seen all along the main stem in the widely deposited gravel bars.

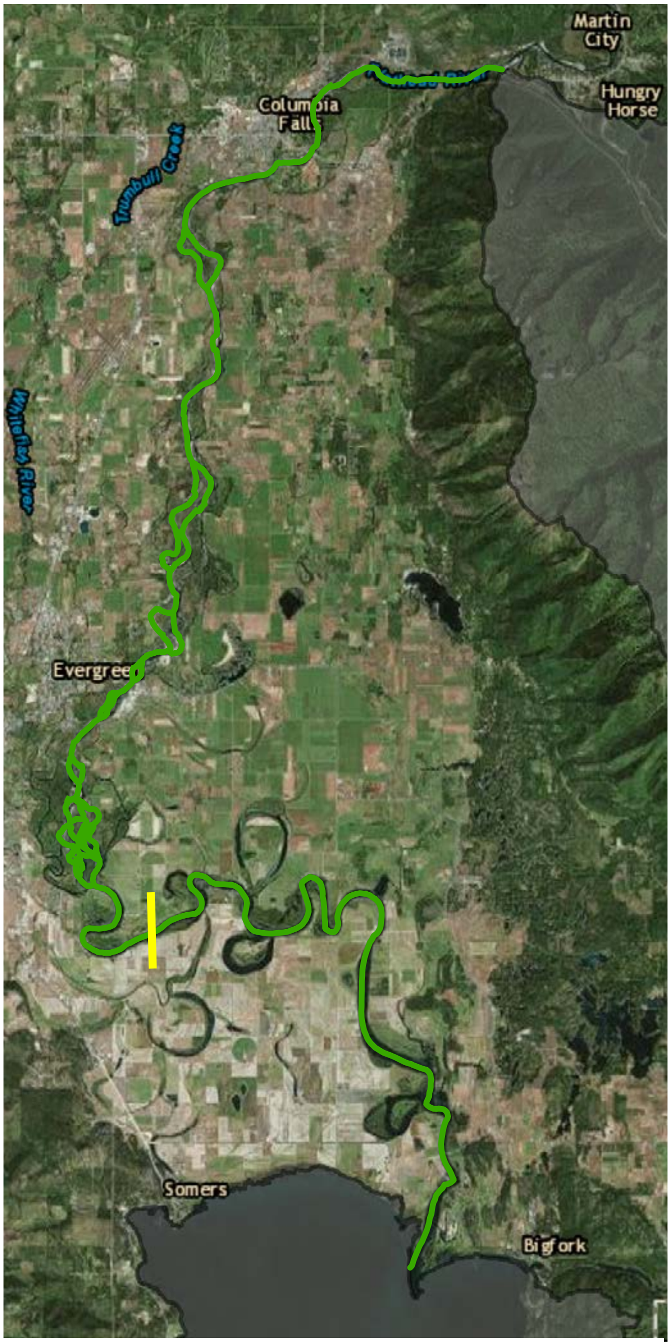

Figure 26. Mainstem Flathead River. The yellow line indicates approximately where the lower 22 miles of the river begins.

The Problem

The Flathead River is not currently listed for any impairments, but it is a major concern for many watershed organizations, landowners, and community members in the Flathead-Stillwater watershed. Most of these concerns are focused on the lower 22 miles before its confluence with Flathead Lake (Figure 26). This section of the river has experienced extreme erosion for many years, threatening critical lands and private property. The lower Flathead is within the "lake effect zone" of the Salish-Kootenai Dam (formerly known as Kerr Dam). Water management by the dam causes a 10-foot fluctuation in water levels during the summer, presenting unique challenges for riverfront property owners, such as streambank erosion, lack of vegetation, and habitat degradation (Figure 27). Establishing riparian vegetation is difficult due to the inconsistent water levels. Planting projects are often forced to move back from the shoreline to prevent active erosion from reaching them. Human influences, such as residential development, farming up to the shoreline, streambank rip-rapping, historical streambank stabilization techniques, removal of riparian vegetation, and wave effects from boats (Figure 28), force these unstable shorelines to erode even faster. The

Flathead River is also susceptible to nutrient loading from farming activities along its own shores, and it is at the receiving end of many rivers in the Flathead-Stillwater watershed that have significant nutrient loading.

Figure 27. Example of effect of fluctuating water levels on Flathead River (Poindexter Slough).

Figure 28. Historical streambank stabilization technique using car bodies on Flathead River near its confluence with the Stillwater River.

What's been done?

There is a long history of research, restoration, and conservation on the Flathead River, especially on the lower 22 miles just north of Flathead Lake. The Flathead River Commission received DEQ funding in 2011 to develop an agricultural impact report to establish TMDL values for pollutants (Wendt, 2011). This report identified nutrient loading areas by integrating the types and locations of fertilizer use. The Flathead River empties directly into Flathead Lake, which is currently listed as impaired for nutrients, so understanding the sources of these fertilizers will help prevent nutrient loading in the Flathead River and, ultimately, Flathead Lake.

The Flathead Lake Biological Station developed a map of shoreline types identifying severe erosion, moderate erosion, and no erosion sites along the lower 22 miles of the Flathead River. These maps also identify current docks (from 2010), locations of car bodies historically used as stream stabilization, and other types of stream stabilization techniques used along the river, such as rip rap, wood retaining walls, stump/log stabilization.

The River to Lake Initiative (R2L) has worked almost exclusively on protection and restoration of the shorelines of the Flathead River and Flathead Lake. Since its creation, R2L has protected and/or restored over 5,000 acres of land along the Flathead River through conservation easements and/or restoration projects. Past restoration projects include revegetation of riparian buffers, as well as some experimentation to test different techniques (Figure 29). Some of these techniques include: building exclosures to protect plantings from deer browse, using weed mats to combat weed growth, using tree tubes to combat against vole browse, building passive regeneration exclosures, and planting willows or cottonwoods at different elevations from the surface level (or groundwater level).

Recommended Solutions

R2L and the River Steward Program have worked extensively with many landowners along the Flathead River in their ongoing efforts to reduce bank erosion and filter agricultural runoff. Targeted landowner outreach, neighbor-to-neighbor connections, and public meetings will facilitate the inception of new projects in the future.

Figure 29. River Steward (2016) planting project on Flathead River.

The Flathead River Commission (FRC) is also working on several projects on the lower Flathead:

- Flood Inundation Mapping (FIM) – a collaboration with USACE, FCD, and USGS to assist residents and local agencies in understanding flood risk and mitigation. Thus far, FIM models are complete from Hungry Horse Dam to Highway 35. The lower part of the river (Highway 35 to Flathead Lake) requires the installation of a new discharge component on the gauge at Foy's Bend. The final maps will also aid realtors, property purchasers, and residents who want to dispute FEMA flood elevation maps.
- Special Area Management Plan (SAMP) for the lower 22 miles of the Flathead River. The SAMP aims to provide a framework for efficient and effective resolution of many of the challenges facing landowners on the lower Flathead. It is a comprehensive planning tool that will include policies, standards, and criteria for evaluating proposals to avoid, repair, or mitigate negative impacts caused by operational management of the Salish-Kootenai Dam. The SAMP will effectively streamline the permitting process for landowners trying to repair or mitigate their property due to the high erosion levels because of the fluctuating stream height.
- A "No Wake" Zone on a portion on the Flathead River to attempt to prevent some of the severe erosion occurring to streambanks due to wave action from speed boats in the summer. More investigations is required by FWP before initiating this process. FRC is also interested in starting an Erosion Monitoring Project for the lower Flathead; however, more information is needed.

7.2.4 Haskill Creek

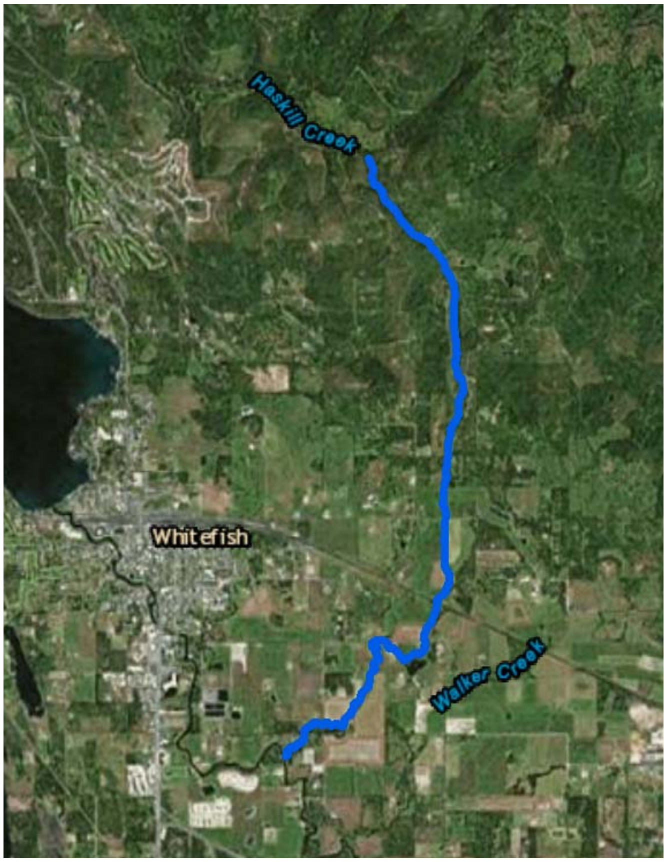

Figure 30. Haskill Creek.

Haskill Creek begins at the convergence of four tributaries in the steep terrain of the Whitefish Range. The impaired section of the creek begins at Haskill Basin Pond and flows for 8.5 miles to its mouth on the Whitefish River (Figure 30). The land along the creek is mainly forested, with commercial (Whitefish Mountain Resort), urban, residential, and agricultural development. The headwaters is the primary water source for the City of Whitefish. The upper half of the basin is forested (owned by the DNRC and F.H. Stoltze Land & Lumber Co.) while the lower half is dominated by agriculture and private landowners. The creek supports populations of westslope cutthroat trout and potentially bull trout. The westslope cutthroat trout inhabit the middle portion of the drainage, but at low numbers because non-native brook trout predominate.

The Problem

Haskill Creek is listed as impaired for sediment, which affects aquatic life. An assessment sponsored by the Haskill Basin Watershed Council (HBWC) in 2003 identified stream conditions and both direct and indirect modifications that have elevated the sediment load and have impaired aquatic habitat (Water Consulting, Inc., 2003). These modifications include:

- land cover disturbance.
- physical stream straightening.
- floodplain encroachment.
- clearing of riparian vegetation.

Most of these disturbances have occurred on residential and commercial developments. These modifications have altered channel stability and reduced the quality and quantity of critical spawning, rearing, and overwintering habitat for fish populations. To exacerbate the situation, the hydrology of this creek is highly influenced by spring runoff, rain-on-snow, and rain-on-snowmelt events. The result has been high magnitude flood events in this watershed, which can cause even more erosion downstream.

What's been done?

In February 2016, officials from the City of Whitefish, FWP, Stoltze Land & Lumber Co., and the Trust for Public Land finalized an agreement to permanently protect 3,020 acres of land in the Haskill Basin watershed through a conservation easement. This agreement effectively supports local timber jobs, recreational opportunities for residents, and key fish and wildlife habitat, while also protecting the drinking water supply for the City of Whitefish. The Stoltze Land & Lumber Co. has been a practitioner of sustainable forestry throughout the Haskill Basin and has established a well-designed system of roads that has been carefully maintained in accordance with BMPs to protect water quality. They have also adhered to the Streamside Management Zone law and applied Stewardship Forestry principles throughout all of their timber harvest activities. The Stoltze Land & Lumber Co. even implemented water quality monitoring in the early 1990's on a few of the tributary streams to Haskill Creek to keep up to date on current water quality conditions (Curtis, 2010).

After the completion of the initial creek assessment, HBWC identified priority sites along Haskill Creek for restoration efforts in a more comprehensive pollutant source assessment and water quality restoration plan (River Design Group, 2004). This assessment identified 14 priority sites for restoration, and it has been the main driver for restoration work to date. The assessment also served as a resource to DEQ scientists as they developed a sediment TMDL for the stream.

Since the completion of the initial assessments, HBWC (in collaboration with FCD) has implemented projects on all of the priority sites, with the exception of the culvert on Haskill Basin Road (see Recommended Solutions). Two projects located on private land in the lower part of the basin, the Voermans/Klungness (initiated in 2005) and the Reimers (initiated in 2010; Figures 31, 32, and 33), addressed the steep, eroding banks. Banks were excavated and contoured to re-construct floodplain benches. Woody debris structures were installed to dissipate energy and enhance aquatic habitat. Riparian vegetation was planted throughout. Both projects reduced sedimentation significantly and provided educational opportunities to the Whitefish High School Project FREEFLOW group, who volunteered time to help plant the riparian vegetation. Both projects also mitigated many of the issues identified in the 2004 assessment.

Figure 31. A segment of the Reimer reach before project implementation.

Figure 32. Floodplain excavation on the Reimer reach.

Figure 33. Project FREEFLOW students planting riparian vegetation on excavated floodplain.

Recommended Solutions

HBWC and WLI have identified several projects and BMPs necessary for improving water quality and habitat along Haskill Creek, and FCD will help facilitate their implementation. HBWC has several engaged landowners throughout the Haskill Basin, and they will continue to help restore and maintain the health of Haskill Creek with the goal of eventually delisting the creek. Currently, there are a number of potential projects and BMPs that could be implemented along the creek to help reduce sediment.

- New channel-floodplain construction/reconstruction.
- Channel re-shaping.
- Installation of riparian and upland vegetation.
- Improved stream management by the Big Sky Mountain Resort on Haskill Creek tributaries (First Creek).
- Improve fish passages in headwaters and in valley bottom reaches.

WLI also has interest in pursuing restoration work on Haskill Creek. In their *Whitefish Area Water Resources Report: A Status of the Whitefish Lake Watershed and Surrounding Area* (WLI, 2015), they identified many potential water quality improvement tasks to be done on Haskill Creek, including:

- Developing a discharge plan to maintain in-stream flows in Haskill Creek to support aquatic life.
- Continued research and water quality monitoring on Haskill Creek and other Whitefish River tributaries.
- Identify and protect genetically pure westslope cutthroat trout populations.
- Assist HBWC with restoration and habitat protection projects.

HBWC's main priority at this time is the replacement of a poorly functioning culvert on Haskill Basin Road (Figures 34 and 35). The culvert is undersized and perched; thus, it promotes erosion and prohibits fish passage. FCD and HBWC have secured grant funding (DNRC HB 223 grant) to engineer and design a more appropriate creek crossing.

Figure 34. Upstream end of Haskill Basin Rd. culvert.

Figure 35. Downstream end of Haskill Basin Rd. culvert.

7.2.5 Krause Creek

Krause Creek originates in the Swan Mountains, flows west and empties into Echo Lake at the base of the Swans (Figure 36). It is a losing intermittent stream, which means that is loses surface water to groundwater as it flows downstream. It flows during the wet season (spring and early summer snow melt and rain events) and is normally dry during hot summer months. The dominant land cover is 90% evergreen forest. Ownership on Krause Creek is split between the upper portion owned by the USFS and DNRC and the lower portion by private property owners. The upper watershed basin area is used for recreation, such as hiking and skiing.

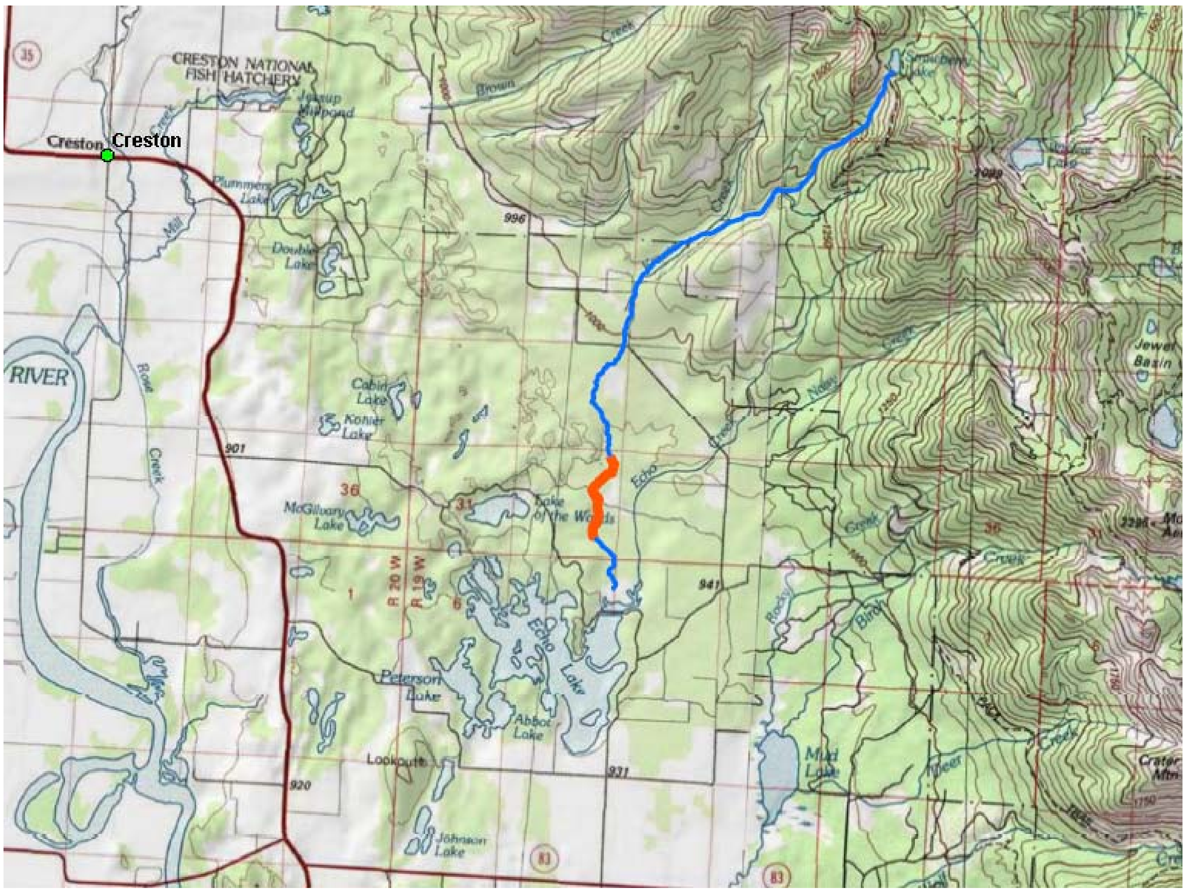

Figure 36. Krause Creek location and location of 2016 FCD project site (source: *Krause Creek Restoration Feasibility and Alternatives Analysis,* 2016)

The Problem

Krause Creek is currently not listed for any impairments and is not directly connected to any of the listed impaired streams; however, channel instability and erosion has become a concern to many of the landowners along the creek. Natural sedimentation and streambank mass failures have occurred in the headwaters where steep slopes are prevalent. A history of stream channelization in the lower basin has changed the creek from a multichannel, alluvial fan system, which used to infiltrate into the groundwater, to a single, channelized creek, which now runs directly into Echo Lake. These changes have resulted in increased flow velocity during spring runoff and rainfall events. Channelization was done to alleviate flooding and facilitate land development, but in recent years, erosion appears to be accelerating, especially during high velocity spring runoff events. The creek is actively downcutting and eroding laterally, which is also causing the water table to drop and dewater the surrounding forest (Figures 37 and 38). Furthermore, the steep banks are a barrier to wildlife crossing. The current conditions could potentially be amplified by significant changes in the upper watershed, such as wildfire or timber harvesting. The significant erosion contributes high amounts of sediment into the stream, which then enters Echo Lake (Applied Geomorphology & Confluence Consulting, Inc., 2016). The landowners living along Krause Creek are not only concerned by the loss of land on their property due to stream downcutting and widening, but they are also concerned for the health of their land and the health of the surrounding ecosystems.

Figure 37. Krause Creek incising on lower reach before spring flow occurred, view from outside creek channel.

Figure 38. Krause Creek incising on lower reach before spring flow, view from inside the creek channel.

What's been done?

In 2015, FCD received a Watershed Planning Grant from DNRC's Renewable Resource Grant and Loan (RRGL) program to conduct an assessment of Krause Creek to understand the history and problems concerning the creek and outline potential solutions. FCD procured a consultant from Confluence Consulting, Inc. (with Applied Geomorphology, Inc.) to conduct the analysis, and the resulting document, Krause Creek Restoration Feasibility and Alternatives Analysis (Applied Geomorphology & Confluence Consulting, Inc., 2016), identified management restoration alternatives for the upper, middle and lower watersheds and served as a foundation for FCD's RRGL grant application for implementation of a watershed restoration project. Funding was not allocated for this project during the 2017 legislative session, but the application may be re-submitted for 2018-19. The three reaches identified in the planning assessment document, the upper watershed, the transport reach, and the response reach (lower watershed), have distinctive geomorphic processes, human influences and channel responses. The soil in the upper watershed is highly erodible and periodically delivers large sediment loads to the creek. Several mass failures on upper tributary drainages were noted. The transport (intermediate) reach flows across a broad alluvial fan. This channel is steep and single thread with high sediment transport capabilities. The response reach begins at the toe of the original alluvial fan. This is the depositional area of the creek and is characterized by extensive channel and floodplain deposition of coarse gravels. The response reach is where FCD is proposing to implement a restoration project. The selected solution involves working with a local landowner to excavate an inset floodplain at a lower elevation along a 625-foot-long segment of the creek and establish grade control (Figure 41), both of which will slow water flow, dissipate energy, and reduce downcutting. An undersized culvert will also be replaced with one that can withstand a 25-year flood event, which will reduce backflow and protect the banks from additional erosion and flooding (Figures 39 and 40). The implementation of this project would reduce sedimentation to Echo Lake, while mitigating the dewatering of upland forest and facilitating wildlife movement.

Figure 39. Undersized culvert.

Figure 40. Undersized culvert during spring runoff.

Recommended Solutions

The following information is a summary of some of the general land management options described in the *Krause Creek Restoration Feasibility and Alternatives Analysis*.

The upper watershed produces the primary source of sediment due to the highly erosive soil material found there. The following strategies may have a positive effect:

- Manage the land carefully with regard to fire suppression, road construction and logging to minimize sediment loading downstream.
- Construct an impoundment to reduce peak flows and trap sediment.
- Re-route part of Krause Creek to Echo Creek to reduce amount of flow in Krause Creek.

The transport reach serves largely as an efficient flood control channel for landowners in the area, though the steep slope and high sediment concentrations in the reach make it prone to high energy transport of sediment and wood. The following management strategies may have a positive effect:

- Ongoing channel maintenance for conveyance.
- Maintain infrastructure (bridges and culverts) for conveyance.
- Distribute flows strategically across the fan surface to promote infiltration and groundwater recharge as well as sediment storage. This would restore Krause Creek to its historic function, though would also increase flooding concerns for local residents.

The response reach in the lower watershed has a patchwork of privately-owned property. The following management strategies may be helpful for erosion issues in this area:

- Infrastructure maintenance at bridges and culverts.
- Distribute flows and sediment across fan surface in multiple channels.
- Construct sediment traps.
- Site-specific projects such as creating an inset floodplain and implementing grade control.

FCD has initiated the formation of a watershed group to facilitate management and restoration efforts on Krause Creek. It held an informational landowner meeting in September 2016, and about 25 attended. If interest in the group continues, they could use the FCD assessment as a starting place to understand the history, issues, and potential solutions for Krause Creek.

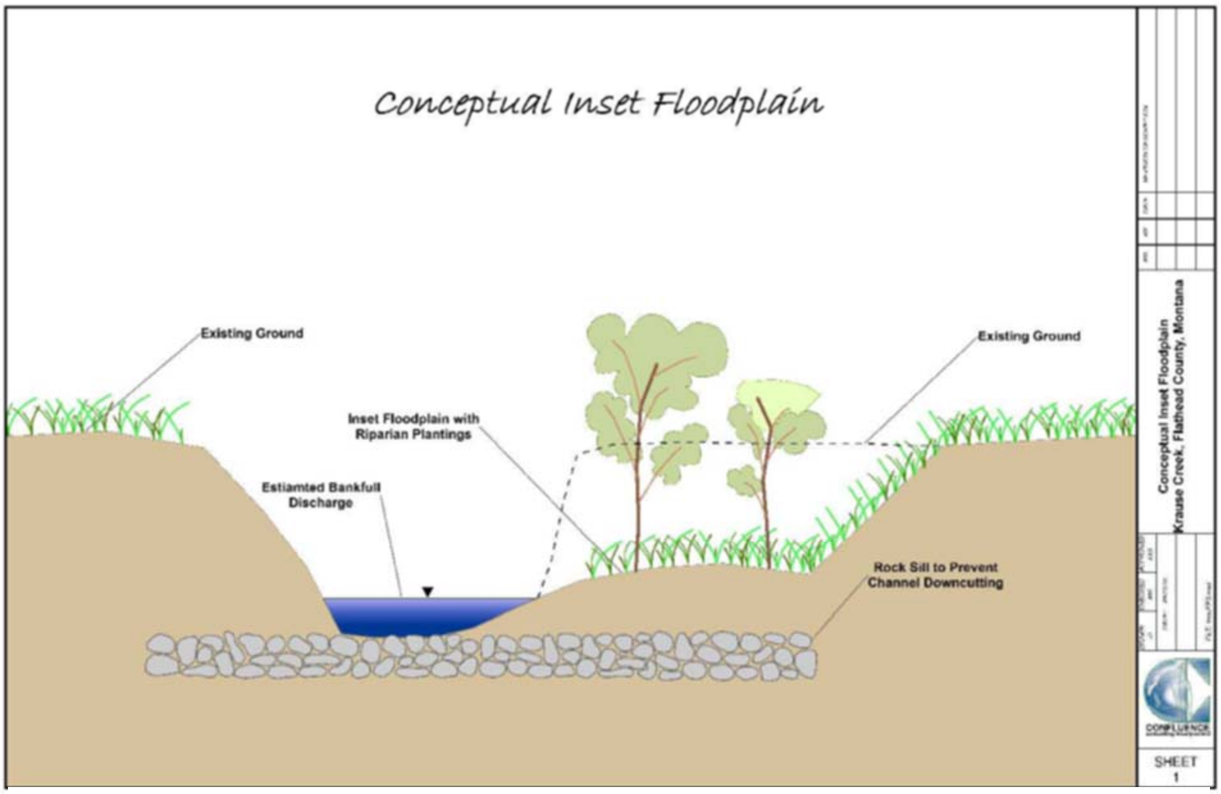

Figure 41. Preferred alternative for Krause Creek restoration (Applied Geomorphology & Confluence Consulting, Inc., 2016.

7.2.6 Logan Creek

The headwaters of Logan Creek are on Ashley Mountain in the Salish Mountains, and the creek flows north for 21.6 miles through USFS, Weyerhaeuser, DNRC, and private agricultural lands before emptying into the northwest side of Tally Lake (Figure 42). From Tally Lake, the creek discharges on the northeast side and flows eight miles to its confluence with the Stillwater River. The only section in the lower part owned by private landowners is in Star Meadows, a 5-mile stretch of the stream in a broad meadow abundant with beaver dams and deep, slow-moving water (Figure 43). Trees are scarce due to the high-water table, and riparian vegetation is dominated by willow species and sedges. Between Star Meadows and Tally Lake, Logan Creek becomes a powerful stream that, during high flow periods, is capable of moving large substrate. The presence of Logan Falls presents a fish passage barrier between Tally Lake and Star Meadows, and it causes the stream to flow with increased velocity to the river. Brook trout, followed by rainbow trout, currently dominate the fisheries population in Logan Creek above Logan Falls, making it a popular area for anglers. Other fish populations include redside shiners, sculpins and suckers (DEQ, 2014b).

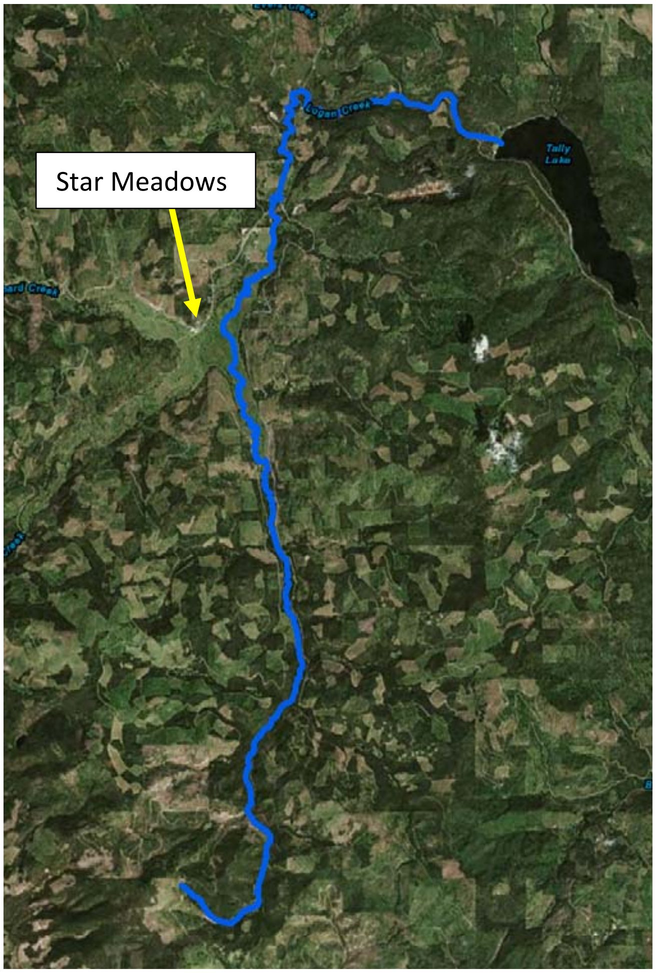

Figure 42. Logan Creek. The 21.6 miles of Logan Creek upstream from Tally Lake is impaired for sediment.

The Problem

The 21.6-mile section of Logan Creek upstream from Tally Lake is currently impaired for sediment, as well as non-pollutant, physical substrate habitat alterations due to timber harvesting, streambank modifications, and forest roads. Timber harvesting and road building has occurred in upper Logan Creek (south of Star Meadows) since 1970, and these activities have increased sediment load, decreased channel stability, and raised fine sediment levels. Although most of the sediment contributions in Logan Creek are from streambank erosion, DEQ estimates that most of this is naturally-occurring. Agricultural activities, such as cattle grazing and hay production, have occurred in the Star Meadows area since the early 1900's, which also contributes sediment to the creek (Stevens, 2003).

What's been done?

The Logan Creek Water Quality and Aquatic Life/Fisheries Status Report (Stevens, 2003), identifies activities, such as unpaved forest roads and fire susceptibility, that may impact sediment contributions to Logan Creek. This report was completed in response to the original DEQ impairment listing on Logan

Creek, and it concluded that Logan Creek is a healthy stream that fully supports aquatic life and cold water fisheries beneficial uses.

Timber harvest BMPs have been implemented since 1985 in response to a mountain pine beetle epidemic that caused extensive tree mortality. Fortunately, Logan Creek was afforded a greater degree of protection than other streams that were harvested earlier in the century because water quality protection was beginning to become recognized as an important prerequisite for good land management. Because of this, there is relatively low evidence of riparian harvest within the Logan Creek watershed. In 1995, the Flathead National Forest (FNF) adopted the standards of the Inland Native Fish Strategy (INFISH), which established more stringent standards for riparian buffer zones and protection for fish habitat. INFISH continues to be followed today and it has significantly reduced the sediment contributions to the creek. Since 1978, FNF has monitored stream channel stability and fish habitat condition along the upper portion of Logan Creek, as well as below and above the Star Meadows reach. This monitoring has concluded that all of Logan Creek above Tally Lake is generally stable, including temperatures that are suitable for aquatic life and low-impact sediment contributions (Stevens, 2003).

Figure 43. Star Meadows (Stevens, 2003)

FNF proposed the Logan Creek Restoration Project (USFS, 2004) to reduce road densities, upgrade the drainage characteristics of remaining roads, and reduce the risk of catastrophic fire by restoring the forest to a more natural condition. Since then, BMPs have been implemented on 155.5 miles of roads in the Logan Creek watershed, and FNF planned to implement about 85 miles of road BMP improvements in the Griffin Creek watershed (tributary to Logan Creek) in 2015 (DEQ, 2014b). Since the completion of the Flathead-Stillwater TMDL, 19 miles of road BMPs on National Forest System Roads in the Griffin Creek watershed have been implemented. The remaining miles will likely be completed under two separate timber sales between 2017-2020 (Personal communication, Mitchell Guenthner, USFS, 11/15/16).

Recommended Solutions

Collaboration between FNF, FWP, and other organizations in the Flathead-Stillwater watershed are key for future restoration and conservation work. Though restoration activities would be very effective via forest road and timber harvest BMP implementation, the most important factor in sediment load reduction in Logan Creek may simply be time. The 2003 status report identified activities that may contribute sediment, but it also concluded that Logan Creek is fully functioning and supporting its beneficial uses. Since then, multiple miles of road and timber harvest BMPs have been implemented and maintained. The next step for Logan Creek may be de-listing, which requires DEQ to reassess and evaluate its status. Outreach to the private landowners in the Star Meadows area would also be effective, especially with regard to agricultural BMPs they could implement to reduce sedimentation. This reach is susceptible to sediment loading because of its high population of beaver dams and slower water flows.

7.2.7 Sheppard Creek

Sheppard Creek originates in the Salish Mountain Range and flows 16 miles to its mouth at Griffin Creek, a tributary to Logan Creek (Figure 44). Most of Sheppard Creek is on public land (USFS), except for the lower reaches of the creek, which is privately-held land in the Star Meadows area. The upper 2.4 miles of the creek contain a genetically pure population of westslope cutthroat trout and has been a part of a USFS-led cutthroat trout conservation program since 2001 (DEQ, 2014b).

Figure 44. Sheppard Creek.

The Problem

Sheppard Creek is impaired for sediment, as well as the non-pollutant of alteration in streamside vegetative covers. Agriculture, rangeland, and timber harvesting have contributed to the sediment loads in Sheppard Creek since its first listing in 1998. After being delisted in 2000 because of insufficient data, it was relisted in 2006 due to excess sediment contributions associated with timber harvest, grazing in riparian areas, and forest roads (DEQ, 2014b). The portion of Sheppard Creek with the most disturbance is in the lower reach as it enters Star Meadows, where habitat and vegetation have been altered by grazing and hay production. Sheppard Creek has also been affected by wildfire; for example, the Brush Creek fire burned the upper portion of the Sheppard Creek watershed in 2007, causing riparian shrub mortality and streambank instability (USFS, 2008). The Flathead National Forest (FNF) and FWP are very interested in restoration and conservation work in Sheppard Creek because of the small population of genetically pure westslope cutthroat trout residing in the creek, which could be threatened by high levels of sediment.

What's been done?

In 2001, FNF employees and volunteers physically removed brook trout from Sheppard Creek using backpack electroshockers, and they installed a barrier to block further movement into the headwaters.

Although it was economically unfeasible to remove all brook trout, complete eradiation of brook trout is intended in the near future to protect the genetically-pure cutthroat trout population. Efforts continued between 2001 and 2003 using multiple electrofishing passes per year (and 198 days of employee and volunteer labor). This work resulted in increasing the cutthroat population to about 500 fish. Subsequently, this work was repeated from 2004 to 2006, and the cutthroat population reached about 600 fish by 2006 (Gardner, 2009). The Brush Creek fire halted suppression efforts in 2007 and 2008, but it was taken up again in 2009 with the help of the Flathead Valley Chapter of Trout Unlimited. In the 2009 Sheppard Creek Westslope Cutthroat Trout Restoration Project report (Gardner, 2009), plans were made to continue work in 2010; however, no work was planned from 2011-2013.

Sheppard Creek was also included in the *Logan Creek Ecosystem Restoration Project* (USDA Forest Service, Flathead National Forest, Tally Lake Ranger District, 2004) in an attempt to reduce sediment loading in the Logan Creek watershed. As a result, BMPs have been implemented on approximately 49 miles of timber roads in the Sheppard Creek drainage. In addition to road BMPs, since 2007, 75 miles of ditches and culverts have been cleaned, eight culverts have been upgraded in small tributaries, and upgraded aquatic organism passage culverts have been installed in upper Sheppard Creek and contributing tributaries.

In response to the Brush Creek fire in 2007, FNF proposed a post-fire harvest of marketable wood products. Additionally, no new roads would be built, monitoring of wildlife, fish, soils, water, and vegetation would take place, and BMPs would be implemented widely to protect water quality.

Recommended Solutions

Continued collaborations among FNF, FWP, and other organizations in the Flathead-Stillwater watershed are key for future restoration and conservation work. Sheppard Creek is similar to Logan in that more restoration activities could be conducted, but the most important factor reducing sediment may be time. A future assessment by DEQ may result in de-listing. Landowner outreach and education about livestock grazing and hay production may be effective, especially in the Star Meadows area.

7.2.8 Spring Creek

Spring Creek originates northwest of Kalispell and flows 4.8 miles southeast before joining Ashley Creek (middle section; Figure 45). This Spring Creek is found west of the Stillwater River, unlike the Spring Creek found east of the Whitefish River. The primary land cover is agricultural, rural residential, and urban.

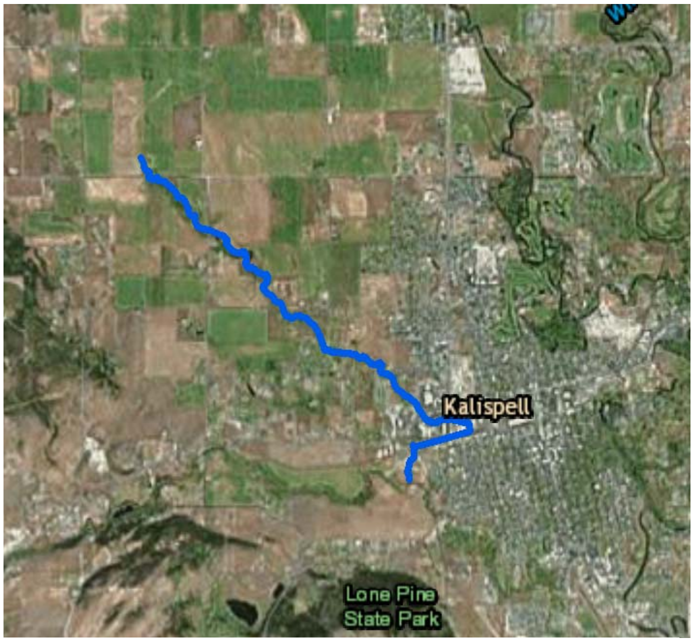

Figure 45. Spring Creek.

The Problem

Spring Creek is impaired by nutrients (total phosphorous and total nitrogen) and dissolved oxygen. The main source of nutrients to Spring Creek is suburban septic systems, which contribute nearly half the nitrogen and phosphorus load to Spring Creek. The other half of nutrient contributions comes from the fertilizers associated with agriculture and urban activities.

What's been done?

At this time, FCD is unaware of any NPS reduction projects implemented on Spring Creek.

Recommended Solutions

Recommended BMPs to reduce nutrient contributions to Spring Creek include those specifically for septic systems, agriculture, and urban activities. Implementing BMPs to address septic systems will have an especially large impact because of the high concentration of them in this watershed. Septic BMPs include:

- **Control water use**: repair leaky faucets, fixtures and appliances; install low water use appliances and fixtures; be aware of what goes down drains; do not empty roof drains and sump pump water into septic systems; and spread water uses evenly throughout the day and week.
- **Inspect septic system**: have septic system inspected at least yearly by a professional.
- **Pump Frequently:** Pumping of septic systems should occur every 3 to 5 years depending on the number of people in the household, the amount of wastewater generated, septic tank size, and volume of solids in wastewater.
- **Care for drainfield:** avoid planting water-loving shrubs with deep root systems or trees near the drain field; keep all vehicles, bikes, snowmobiles, etc. off the tank, pipes and soil treatment area; keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from drainfield; stop cutting grass over soil treatment area a couple weeks before the rest of the lawn as extra growth will help insulate the area and prevent freezing.

7.2.9 Stillwater River

The Stillwater River originates in Russky Creek in the Whitefish Range in Lincoln County and flows south until it empties into the Flathead River south of Kalispell (Figure 46). The impaired segment begins where Logan Creek enters the river and extends almost 46 miles to its confluence with the Flathead River. About ¾ of the land surrounding the impaired stream reach is owned by private landowners, while the other ¼ is held by the USFS. Small portions are also held by DNRC and FWP. There are currently 13 documented fish species found in the Stillwater drainage, 8 of which are native to Montana (including bull trout and westslope cutthroat trout), though populations of these native fishes are decreasing. The river is known for northern pike fishing in many of the reaches.

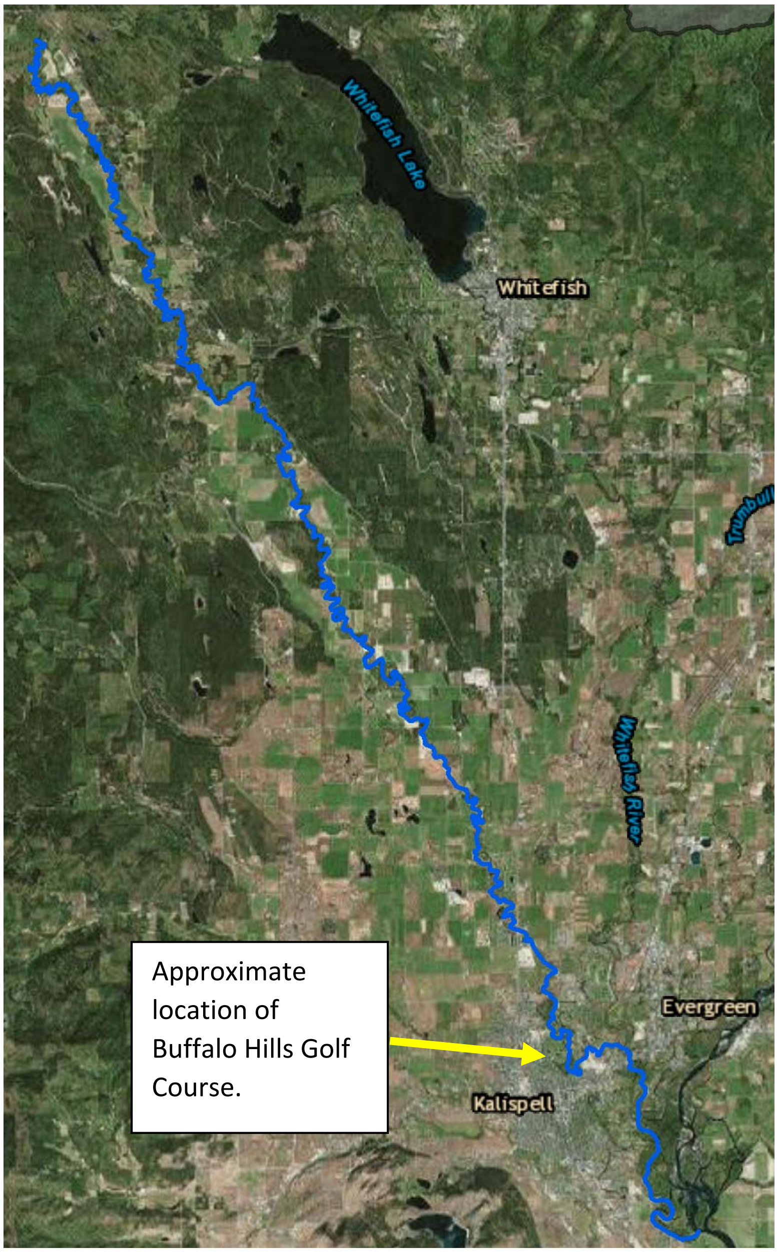

Figure 46. Stillwater River from Logan Creek to Flathead River.

The Problem

The Stillwater River is listed for sediment and alteration in stream-side vegetative covers. Many sites along this river warrant attention. The soils of the Stillwater River are derived from alluvium and underlain by stratified deposits of sand, silt, and gravel. Much of the river is dominated by extremely eroding high banks (> 30 feet) (DEQ, 2014b). DEQ did not collect any physical data for the Stillwater River, but, instead, observed the river by boat to help evaluate the sediment and alteration in streamside vegetation covers listing. (DEQ, 2014b). DEQ personnel observed that major sediment contributions occurred from disturbances caused by livestock and riparian vegetation removal (DEQ, 2014b).

What's been done?

Erosion is an ongoing issue in the vicinity of the Buffalo Hills Golf Course (BHGC), a public golf course in Kalispell (Figures 49 and 50). DEQ personnel observed evidence of bank stabilization efforts by BHGC, including coir fabric (coconut husk fabric) bank layering, willow plantings, and rip rap in a few locations (DEQ, 2014b). BHGC worked with FEMA to place rip rap, willow lifts, and root revetments along their property shoreline in attempts to halt the erosion process. The willow lifts were placed in three different locations and have had varying degrees of success (Figures 47 and 48). While some growth of the willows has occurred, high waters and beaver predation has affected their success. Beavers have chewed down many of the growing willows while high waters have drowned out the lower layers. Maintenance needs to be conducted, along with the possible relocation of the beaver population, to make these willow lifts a success.

Figure 47. New willow lift along eroded shoreline on the Buffalo Hills property along the Stillwater River.

Figure 48. Same willow lift with willows growing out of the top layer and rip rap at the toe.

BHGC submitted a pre-proposal application for 319 funding in July of 2016. They proposed to implement several bank stabilization methods, including rip rap with plantings and willow stakes, and sheet pilling near cart paths to protect infrastructure. However, DEQ chose to not fund this project in 2017. The letter stated:

> "The Buffalo Hill Municipal Golf Course was built within a floodplain of the Stillwater River, lateral erosion and river channel migration across the floodplain is a natural process. The proposed project would limit these processes and potentially increase erosion in downstream sections of the river."

The letter goes on to state that the Watershed Protection Section of DEQ would be able to provide technical staff support to advise on activities necessary to protect infrastructure, so that those activities can be completed in a manner that best considers water quality and natural stream processes.

Recommended Solutions

The erosion issues at BHGC are problematic both for the golf course and the health of the river. The bulk of the sediment issues occurring along the Buffalo Hills property and adjacent properties has occurred due to human alterations of the stream bank, including removal of riparian vegetation and residential development close to shorelines. This situation is particularly difficult because high stream banks on the opposite side of the river limit the amount of space for restoration activities. Also, BHGC was built on the floodplain, which means that that the river will naturally meander and erode streambanks.

Figure 49. Bank undercutting and streambank erosion along cart path along the western shore of the Stillwater River.

Figure 50. Mass failure of streambank on east shore of Stillwater River, across from the golf course under Juniper Bend housing developments.

Replacing current rip rap with vegetation to hold the stream banks in place would be the most natural restoration choice, but the high rates of erosion would make it nearly impossible for the vegetation to establish. The current areas of concern are probably better suited to hard armoring, such as rip rap or sheet piling, to prevent further loss of infrastructure and homes. BHGC should consider implementing BMPs over the long-term, especially after the erosion abates and infrastructure is no longer at serious risk. However, there are several BMPs that could be implemented earlier at BHGC and in the vicinity.

- Plant upland or riparian vegetation to promote better root structure and more stable shorelines.
- Minimize mowing along shorelines to a minimum to allow plant growth.
- Use herbicides to control noxious weeds to promote native plant growth.
- Promote education/outreach to the community members who use BHGC, such as an educational sign. Consider a local fundraiser to gain extra funds for work and to discuss issues with community.
- Perform an analysis of the entire impaired section of the river to identify potential areas for restoration.

With long-term planning and support from FCD and the City of Kalispell, there are numerous possibilities for restoration projects along this stretch of the Stillwater River. A landowner who lives across the river from BHGC contacted FCD in November of 2016 with concerns about their eroding shoreline and the potential loss of their home. Potentially, multiple stakeholders could work together in this area and utilize grant opportunities, such as the DNRC RRGL program, for planning, engineering, and construction. This would also be an excellent opportunity for education and outreach to landowners and the public (e.g. interpretative signs at BHGC).

7.2.10 Stoner Creek

Stoner Creek originates on Blacktail Moutain, west of Lakeside, MT, and flows east through USFS, Weyerhaeuser, and privately-held land before entering Flathead Lake (Figure 51).

Figure 51. Stoner Creek.

The Problem

Stoner Creek is not listed for any impairments, but it flows into Flathead Lake (which is listed for nutrient impairments) and local stakeholders have concerns about excessive nutrients and sediment in the watershed. Given its position as a tributary to Flathead Lake, Section 319 funding could be used for nutrient reducing projects on Stoner Creek. Past water quality sampling by the Flathead Lake Biological Station indicates that Stoner Creek has high concentrations of total phosphorus compared to other tributaries in the Flathead watershed. Water quality sampling also indicated high sediment levels. Both nutrient and sediment contributions can be attributed to increased residential development and riparian vegetation disturbance (Coen, 2003). Historic timber harvest in the watershed and erosion of unpaved roads have also led to sedimentation in the creek.

What's been done?

A number of BMPs have been implemented to address sediment contributions from unpaved roads in the watershed, including the installation of rolling drain dips and rubber belt diverters. More recently, a project was initiated to pave the 13.5-mile-long Blacktail Mountain Road from Lakeside, MT to the Blacktail Mountain Ski Area. This project is being funded by the Federal Lands Access Program (FLAP), Flathead County, and FNF. Two miles were paved in 2015, and officials hope to have another two miles paved by 2017.

Recommended Solutions

Further research and assessment need to be conducted to better understand the current condition on Stoner Creek. General BMPs that can be implemented in the Stoner Creek watershed include:

- Protect riparian shorelines to promote bank stabilization and nutrient uptake.
- Road and timber harvest BMPs to reduce erosion and protect shorelines.

7.2.11 Lower Swan River

The section of Swan River included in this WRP includes the area between the outlet of Swan Lake and the entrance to Flathead Lake (Figure 52). Lower Swan River is a major tributary of the Lake, and it flows through a patchwork of private property and a small amount of state land.

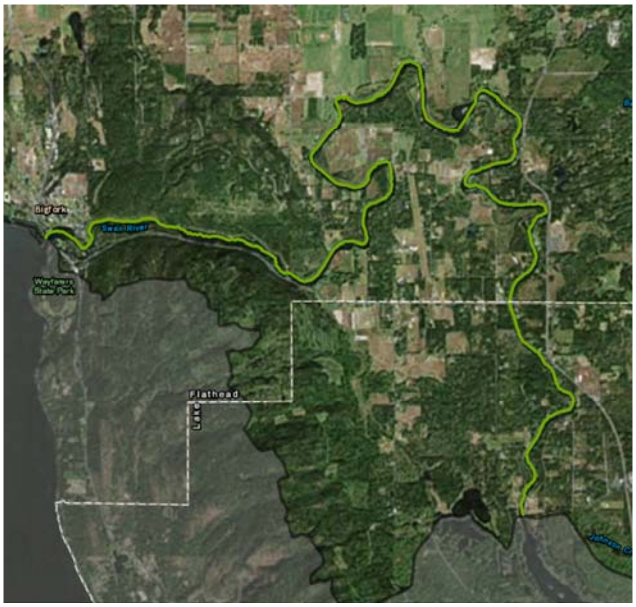

Figure 52. Lower Swan River.

The Problem

Lower Swan River is included in this plan as a stream of concern due to its potential for contributing nutrients, sediment, and other pollutants to Flathead Lake. There was particular concern about this stretch of the Swan because of the relatively high number of 310 permits issued for bank stabilization projects. Additionally, there are concerns about the growing number of home developments along the river. The Swan Basin WRP (Vissichelli, 2010), which includes the upper Swan watershed, cites unpaved roads and stream crossings as some of the major contributors to sediment into the Swan Basin streams, as well as timber harvesting activities.

Recommended Solutions

Road BMPs, restoration of riparian vegetation along streambanks, and timber harvesting BMPs are recommended to reduce the pollutant loading to lower Swan River. Additionally, initiating education and outreach to landowners about causes of NPS pollution and potential solutions would be benefit the river.

7.2.12 Swift Creek

The headwaters of Swift Creek are in the Whitefish Range, northwest of Whitefish. It primarily flows through the Stillwater State Forest (DNRC), but parts of it also include USFS, Weyerhaeuser, and private land. Swift Creek empties into the north end of Whitefish Lake (Figure 53).

Figure 53. Swift Creek.

The Problem

Swift Creek is one of the highest contributors of sediment into Whitefish Lake. Sedimentation from the creek peaked in the early 1930s, when the first large scale timber harvest and road building efforts occurred in the Lazy Creek and Swift Creek drainages. It was first listed as impaired for sediment in 1988, but was delisted in 2008. DEQ has since determined that 93% of its banks are stable, and most of the sediment loading occurs from natural sources (Schmidt, 2014). In particular, the lower portion of Swift Creek is very dynamic due to highly erodible, non-cohesive sand and fine gravel streambanks. Thus, it is very susceptible to extreme erosion, which can threaten both property and riparian habitat.

What's been done?

The Swift Creek Coalition is a watershed group that formed in 1999 with the mission of maintaining a viable, healthy, and sustainable watershed for the benefit of all users. The Coalition included the entire Swift Creek drainage and its tributaries to the outlet at Whitefish Lake. Their main goal was to produce a comprehensive watershed assessment that would document the existing conditions of vegetation, hydrology, and geomorphology. The Coalition received 319 funds to complete the assessment, and they procured a consultant, Watershed Consulting, who compiled landowner data (DNRC, USFS, and Plum Creek Timber Company) for the report (completed in 2005).

Historical BMP implementation by the logging industry and improvements in road construction practices can explain the drop in sedimentation rates since the mid-1960s, hence the delisting of Swift Creek. In addition, the Streamside Management Zone law—which first went into effect in 1993—has helped to buffer streams from timber harvest practices (WLI, 2015).

Recommended Solutions

The geologic complexity and flashy nature of the creek make it extremely costly and time-consuming to implement bank stability projects on Swift Creek. WLI identified several strategies for erosion mitigation in their Water Quality Improvement Plan (WLI, 2015).

- **Lower Swift Creek Restoration:** Develop a restoration strategy for lower Swift Creek through an open dialogue with landowners and agencies to provide ecosystem integrity and private lands protection for this high energy/delta stream reach (multiple agencies and private landowner consensus needed).
- **Swift Creek Drainage Culvert Replacements**: Mitigate remaining culverts found to block fish passage if no isolated genetically pure strain Westslope cutthroat trout are found above (DNRC lead).
- **Swift Creek Clay Banks:** Decrease sediment and nutrient loading to Swift Creek by stabilizing the toe of the slope at mass wasting sites.

7.2.13 Trumbull Creek

Trumbull Creek originates in the Whitefish Range and flows south towards Kalispell where it meets East Spring Creek before reaching the Stillwater River (south of the confluence of the Whitefish and Stillwater Rivers). Land ownership in the lower watershed is primarily private and use is both agricultural and residential. The upper watershed is largely forested and the ownership is both public (USFS) and private (F.H. Stoltze Land & Lumber). The creek is popular with anglers because of its sizable population of non-native brook trout.

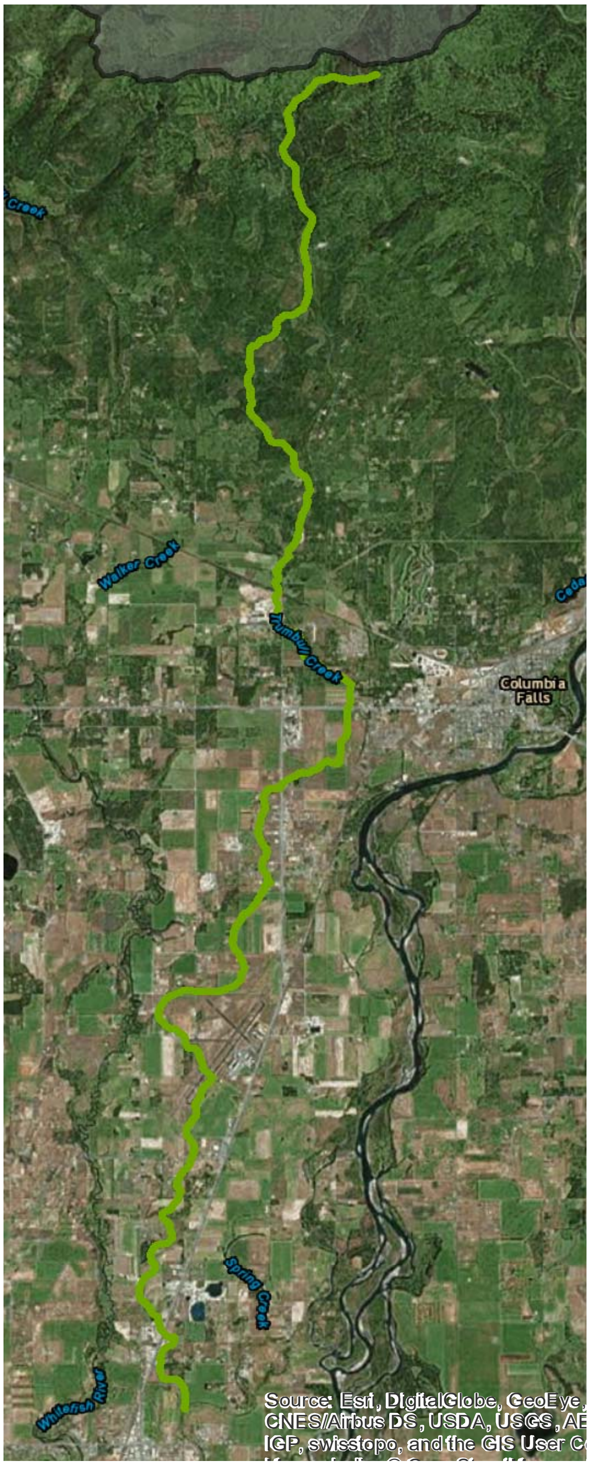

Figure 54. Trumbull Creek.

The Problem

No impairments have been identified for Trumbull Creek, but it has been a stream of concern for FCD and local landowners for many years. The lower part of the creek was heavily channelized for agricultural purposes beginning in the 19th century. Since then, livestock grazing and encroachment of invasive species have contributed to a loss of channel function and increased flooding. The encroachment of non-native golden willow, coupled with minimal grazing management, have contributed to bank instability, which has exacerbated erosion and flooding. Since it empties into East Spring Creek, which eventually reaches the Stillwater River, this erosion could be impacting sediment in the Stillwater (sediment impaired).

What's been done?

Stoltze Land & Lumber promotes natural resources education at the Trumbull Creek Educational Forest, a 40-acre area dedicated to demonstrating the benefits of good forestry stewardship. Each May, the Family Forestry Expo is held at the forest. During the week, approximately 1,250 local fifth graders tour the forest and learn about forest ecology and management through a series of volunteer-led stations. On Saturday, the forest is open to the public, and a series of logging, horse-packing, and other forest-related demonstrations are performed.

In February of 2017, a $9.5 million, 7,068-acre conservation easement was finalized in the upper watershed of Trumbull Creek. Stoltze owns the property and donated a portion of the land value for the easement, which was a result of a partnership with FWP and the Trust for Public Land. The land is permanently protected from any future commercial or residential development, but will continue to be managed timber and public recreation.

In 2015, FCD completed the Trumbull Creek Restoration Project on a previously-channelized stretch of the creek south of US Hwy 2 East and east of US Hwy 2 North. A landowner had experienced flooding since the 1980s, and it got particularly severe in 2006 and 2010 because of above average precipitation and several rain-on-snowmelt events. FCD procured funds from DNRC (HB 223 grant program) to excavate 3,200-ft of channel, cut back the golden willows, and install 700-ft of fencing and a water gap. Excavated material was used to restore the existing levees and mitigate runoff. This work restored flow and helped mitigate flooding (to the extent possible).

Figure 55. Trumbull Creek Restoration Project (2015)

Recommended Solutions

Concurrent to the restoration project, FCD also used the HB 223 grant money to conduct a hydraulic analysis on a crossing on a lower reach of Trumbull (west of US Hwy 2 North, north of Glacier International Airport). An upstream landowner had complained to FCD that the culvert, on Olympia Way, was too small to convey flow and was causing water to flood his property. The analysis confirmed that the two 24-inch culverts were not sufficient for the average annual discharge, and, thus, were exacerbating flooding upstream (River Design Group, 2013). Representatives from FCD visited with the affected landowner in April of 2017 and documented the ongoing nature of this problem. FCD plans to address this culvert, as well as a pond south of the airport, in a near-future effort to restore flow.

Figure 56. Undersized culverts at Olympia Way crossing before spring flow.

Figure 57. Flooding during spring flow caused by backed-up waters from undersized culverts.

7.2.14 Whitefish River and Tributaries (Cow and Walker Creeks)

The Whitefish River begins at the south end of Whitefish Lake and flows through the City of Whitefish before continuing south through mostly rural residential and agricultural lands to Kalispell, where it joins the Stillwater River (Figure 58). Throughout its 25-mile length, it flows through crop and pasture land, as well as forest and residential areas. Most of the landownership is private, but small parcels are managed by DNRC and USFS. The river is home to a variety of native fishes, and 9 of the 11 documented species are considered to be native to Montana, including westslope cutthroat trout and bull trout. Bull trout, which are listed by the USFWS as threatened, are thought to use the river for migration. Cow and Walker Creeks are tributaries to the Whitefish River (Figure 58) and were identified by local stakeholders as streams of concern. They are included with the Whitefish River in this section because they share restoration goals and geographic proximity.

Figure 58. Whitefish River, Cow Creek (upper green), and Walker Creek (lower green).

The Problem

The Whitefish River is impaired for temperature, and the causes of this impairment are human activities, including loss of riparian vegetation (reducing shade; Figure 61), increased channel width, and water diversions. Walker and Cow Creeks are affected by sediment, nutrient, and temperature issues, which are most likely caused by agricultural and residential development. The land surrounding Cow Creek is highly degraded from past and present land use practices, including channelization and excessive livestock use (Figure 59). It transports high phosphorus and nitrogen loads into the Whitefish River. Similarly, Walker Creek flows through agricultural and residential areas (Figure 60) and also contributes to downstream nutrient loading. Both creeks have had stream temperatures as high as 75°F and 77°F, respectively, which are high enough to stress trout species (WLI, 2015).

Figure 59. Cow Creek (WLI, 2015).

Figure 60. Walker Creek (WLI, 2015).

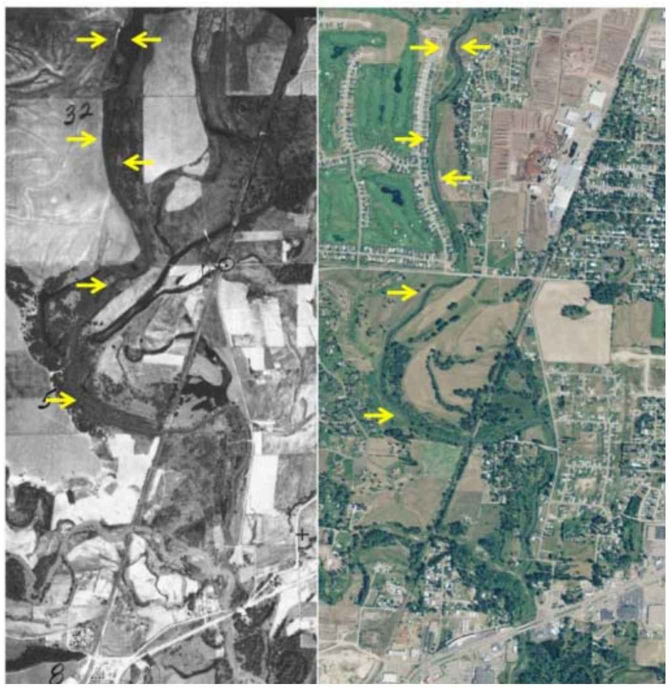

Figure 61. Aerial photographs of the Whitefish River near the mouth in 1936 (left image) and 2009 (right image). Yellow arrows indicate areas where riparian vegetation has been removed and currently provides less shade than in the past.

What's been done?

WLI has done extensive research on the Whitefish Lake watershed, including the Upper Whitefish River, Cow Creek, and Walker Creek, to identify the current issues and pollutant loads (WLI, 2015). WLI staff developed a Watershed Restoration Plan Task Table (WLI, 2015), which outlines water quality improvement activities. The activities cover a range of areas, such as policy and government, education and outreach, research, and restoration and habitat protection, and are in various stages of progress. These activities provide an excellent framework for addressing the water quality issues in all three water bodies, as well as opportunities for partnership with WLI.

The complete table of the Watershed Restoration Plan Task Table from this report can be found at: http://www.whitefishlake.org/download_docs/Final%20Report%202015/ADDENDUM/Addendum%20XXIII%20watershedRestorationTaskTable.pdf

Recommended Solutions

The goal of restoring water temperatures is to have them be consistent with naturally occurring conditions. The most significant mechanism for reducing temperature is to increase riparian shade. According to the Flathead-Stillwater TMDL, riparian vegetation needs to be improved on 66% of the Whitefish River (see map in Appendix G). Riparian vegetation has the added benefits of stabilizing streambanks and preventing pollutants from upland sources from entering the stream, which proactively addresses nutrient and/or sediment impairments. Grazing management in affected areas would also facilitate the growth of sensitive riparian vegetation.

Modifying channel morphology and increasing instream summer flows are both more difficult to mitigate than riparian vegetation. Restoring riparian vegetation will probably also help channel morphology. Reducing the volume of water diverted in the summer would also help restore temperature, but this would be best achieved through education and landowner outreach on improving irrigation infrastructure efficiency and encouraging lower water usage.

Several BMPs would be effective in addressing the impairments and concerns on the Whitefish and its tributaries, including:

- Maintain a 50-ft vegetative buffer along shorelines.
- Grazing management, such as fencing with a water gap off-site watering.
- Practice water conservation to increase instream flows, especially in the summer.
- Check and maintain irrigation diversion structures to ensure efficiency.
- Provide outreach and education programs for shoreline landowners and other community members.

7.3 Implementation Schedule

Riparian restoration is a priority identified throughout this plan. FCD will seek new opportunities for increasing riparian vegetation to address multiple pollutant and non-pollutant concerns. In order to increase the abundance and health of riparian communities, FCD will work to quantify their presence and opportunities for improvement. By quantifying the issue, we can better track and communicate progress toward achieving our goals. An initial aerial assessment was completed for the Flathead River (34 sites), Whitefish River (27 sites), Stillwater River (41 sites), Ashley Creek (64 sites), and the lower Swan River (15 sites) in 2016. Overall, 181 sites were identified that lacked substantial riparian buffers to protect water quality. We plan to ground-truth these sites for accuracy of estimates of site length and condition as well as conduct extensive landowner outreach. In addition to impaired stream segments, FCD will analyze the streams of concern for areas in need of riparian vegetation improvement through similar aerial analysis and ground-truthing efforts. We plan to complete this project (aerial analysis and tracking) within the next five years to help guide riparian restoration efforts and track progress into the future.

FCD has proposed a schedule of proposed or current projects within the Flathead-Stillwater watershed (Table 8). All streams identified in Section 7.2 are included, regardless of their impairment status, unless no specific projects were identified in the WRP development process (i.e., Spring Creek, Stoner Creek, Swan River, and Swift Creek are not in Table 8).

Table 8. Schedule of proposed or current projects on streams or rivers in the Flathead-Stillwater watershed. Possible funding sources listed in bold text have either been applied for or are already secured.

Location	Project / Activity	Description	Project Lead	Timeline	Cost Estimate	Possible Funding Sources[a]
Ashley Creek	Riparian Restoration	1-2 riparian restoration projects completed and new restoration projects planned	Flathead Lakers/ River to Lake Initiative/ FCD	2017 - 2019	$10,000	DEQ 319, FWP-FFIP, NRCS EQIP, NFWF
Coal Creek	DEQ Water Quality Reassessment	Based on the recommendation of recent USFS reports and work done, reassessment of these streams may allow one or more to become delisted.	DEQ	At the request of the FCD and Flathead National Forest	Determined from the standard DEQ assessment process	Standard DEQ assessment process
Flathead River	Riparian Restoration	1-2 riparian restoration project completed and new restoration projects planned	Flathead Lakers	2017 - 2019	$200,000	DEQ 319, FWP-FFIP, NRCS EQIP, NFWF

Location	Project / Activity	Description	Project Lead	Timeline	Cost Estimate	Possible Funding Sources[a]
	CMZ Mapping Continuation	Continue CMZ Mapping efforts upstream of the lower 24 miles.	Flathead Lakers	TBD	$50,000	DNRC RRGL Watershed Planning grant
	No Wake Zone Project	Placement of a “No Wake” Zone on the mainstem of the Flathead River above Flathead Lake to reduce wave-induced streambank erosion.	Flathead River Commission / FWP	TBD	TBD	TBD
	Special Area Management Plan (SAMP)	A comprehensive planning tool to include policies, standards and criteria for evaluating proposals to avoid, repair or mitigate negative impacts caused by operational management of the Salish-Kootenai Dam.	Flathead River Commission	TBD	TBD	TBD
	Flathead River Flood Inundation Mapping (FIM)	Provide flood inundation mapping products for the Flathead River Valley from Columbia Falls down to Polson. Obtain funds to get a discharge component added to the Foy’s Bend stream gauge on Flathead River.	Flathead River Commission, FCD, USGS, ACOE, NWS	2016 – TBD	$17,200/year (for gauge operations and maintenance) $1,000 - $5,000 per agency	In-Kind donations from partners, ACOE Funds
	Erosion Monitoring Program	Create a program to monitor erosion on the Flathead River above Flathead Lake.	Flathead River Commission	TBD	$3,000 (DEQ – Volunteer Monitoring Assistance)	DEQ – Volunteer Monitoring Laboratory Analysis Assistance, In-kind partner donations and volunteer time
Flathead-Stillwater watershed	AIS Prevention and Control	Promote AIS prevention with AIS signs, boat inspections, and education and outreach events and literature	Flathead Basin AIS Work Group	Ongoing	TBD for each specific task as needed.	DNRC AIS Program
	Continuation of Critical Lands Protection	Continue protecting functioning floodplains, wetlands, and riparian areas through conservation easements and other protection measures	Flathead Lakers/ River to Lake Initiative	Ongoing	TBD for each specific task as needed.	NAWCA, NFWF grants, NRCS Agricultural Land Easements
	Landowner BMP/ NPS Education and outreach	Conduct landowner site visits, restoration tours, landowner workshops, presentations, create new	FCD/ Flathead Lakers	Ongoing	$1,000 - $2,000	DEQ 319, SWCDM Water Quality Mini-Grants, MWCC &

Location	Project / Activity	Description	Project Lead	Timeline	Cost Estimate	Possible Funding Sources[a]
		educational literature and videos about NPS pollution and BMPs, etc.				Montana Watercourse Environmental Education Local Mini-Grants Program
	Student BMP/ NPS Education	Form a new annual educational event for students/continue current programs, promote Flathead Watershed Sourcebook Educators Curriculum Guide	FCD/ Flathead Lakers	Ongoing	$1,000 - $2,000	DEQ 319, SWCDM Water Quality Mini Grants, MWCC & Montana Watercourse Environmental Education Local Mini Grants Program
	Potential Project Sites ground-truthing	Float and/or conduct site visits to each impaired stream to compare aerial analysis of potential sites to current conditions.	FCD/Flathead Lakers (River Steward)	2017 - 2018	TBD	In-kind funding
	Watershed Restoration Planning Committee	Watershed Committee to meet bi-annually to update and make changes to the WRP as needed.	FCD	Every 5 Years	TBD	DNRC: Conservation District Development Grant
Haskill Creek	Haskill Basin Road Culvert Replacement	Replacement of undersized culvert causing stream bank erosion due to water backing up during heavy flows and perched outlet.	HBWC/FCD	HB223 Grant Deadline: July 29, 2016	$152,800 (For analysis, design and replacement)	**DNRC: Conservation District HB223 Grant,** DEQ 319**,** FWP-FFIP
Krause Creek	Streambank Restoration	Streambank engineering to reconnect stream to floodplain to slow down erosion and stop dewatering of surrounding forest.	FCD	Planning: Mar-Nov 2017 Implementation: July-Nov 2017 & Apr-May 2018	Proposed Budget: $119,054.65	**DNRC: Renewable Resource Grants & Loans,** FWP-FFIP
Logan Creek	DEQ Water Quality Reassessment	Based on the recommendation of recent USFS reports and work done, reassessment of these streams may allow one or more to become delisted.	DEQ	At the request of the FCD and Flathead National Forest	Determined from the standard DEQ assessment process	Standard DEQ assessment process

Location	Project / Activity	Description	Project Lead	Timeline	Cost Estimate	Possible Funding Sources[a]
Sheppard Creek	DEQ Water Quality Reassessment	Based on the recommendation of recent USFS reports and work done, reassessment of these streams may allow one or more to become delisted.	DEQ	At the request of the FCD and Flathead National Forest	Determined from the standard DEQ assessment process	Standard DEQ assessment process
Stillwater River	Streambank/ Riparian Restoration	Manage erosion and protect water source, utilities and golf course infrastructure by repairing and stabilizing the river bank with armoring and revegetation.	Buffalo Hills Golf Course/ City of Kalispell	Sent in Pre-Proposal: July 25th Was not approved for 2017.	Proposed Budget $332,000	DEQ 319, FWP-FFIP
Trumbull Creek	Streambank Restoration/ Culvert Removal/ Landowner Outreach	Continued communication with landowners along restored sections, outreach to new landowners concerned about high water levels, potential repair or removal of undersized culvert	FCD	2017 - 2022	Culvert Design Cost Estimate (2013): $8,425	DEQ 319, FWP-FFIP, DNRC: RRGL
Whitefish River and Tributaries – Cow and Walker Creeks	Watershed Restoration Plan Tasks (WLI); streambank and riparian restoration	Tasks outlined in the WLI Watershed Restoration Task Table (Whitefish Area Report). Cow Creek: riparian buffer establishment, livestock management, public outreach.	Whitefish Lake Institute/ FCD/Project FREEFLOW/ City of Whitefish	Ongoing	TBD for each specific task. Cow Creek: ~$150,000	DEQ 319, FWP-FFIP, SWCDM Water Quality Mini Grants, DNRC: Conservation District HB223 Grant

[a]Abbreviations: EQIP = Environmental Quality Incentives Program; FWP-FFIP = FWP Future Fisheries Improvement Program; NAWCA = North American Wetlands Conservation Act grants; NFWF = National Fish and Wildlife Foundation; RRGL = Renewable Resource Grant and Loan Program

Section 8: Evaluating Progress and Success

FCD and interested stakeholders will formally review this WRP every five years to assess progress and evaluate goals. Although stakeholders may add new priority projects at any time, the review will provide an opportunity to re-assess needs and adjust BMPs to reflect new knowledge or concerns.

8.1 Criteria and Milestones for Measuring Progress

FCD and stakeholders will use a standard set of criteria (Table 9) to assess progress towards meeting water quality standards. Future projects will identify which criteria indicators will be used to measure progress during the planning phase. Other criteria/indicators may be identified on a project-specific basis**.**

Table 9. Criteria indicators to measure progress towards meeting water quality targets.

Water Quality Issue	Criteria/Indicator
Riparian habitat degradation	Percent of woody riparian vegetation along stream reach Number of miles of fencing installed Number of acres of riparian habitat protected by conservation easements Number of miles of river bank (riparian habitat) restored Number of offsite or water gap livestock watering structures installed
Sediment loading	Number of erosion control projects successfully established Percent of vegetated and stable banks along a stream reach Percent of TMDL sediment load reductions reached Number of miles of unpaved forest roads improved to BMP standards Number of miles of unpaved forest roads decommissioned DEQ sediment assessment indicators
Nutrient loading	Percent of TMDL nitrogen and phosphorus load reductions reached Percent of vegetated and stable banks along a stream reach Number of algal blooms Presence of chlorophyll-a
Temperature/low-flow alterations	Improving trends in temperature and flow changes over time Percent of TMDL temperature load reductions reached Percent of shade provided by vegetated shorelines Number of water diversion structures repaired, replaced, or decommissioned
Community NPS pollution education and participation in NPS pollution BMPs	Number of E&O activities conducted Number of sites ground-truthed Number of landowners reached through E&O activities Percent of landowners contacted have implemented BMPs Number of students reached through E&O activities Number of teachers participating in educational programs
Partnership coordination, development, and support	Number of new watershed groups formed Number of projects and programs conducted in partnership with other organizations Number of organizations in the Flathead-Stillwater watershed to apply for 319 or other funding for NPS pollution projects through the support of this WRP

FCD will use measurable milestones as benchmarks to identify if projects are achieving water quality standards (Table 10). Ideally, these milestones would mapped out in a path that would demarcate relative success in reducing NPS pollution in the Flathead Watershed. However, the stakeholders involved in the development of this WRP wanted to keep it very broad in scope such that all impaired and streams of concern would be included. Moreover, the wide range of potential funding resources, landowner engagement, and organizational willingness makes it challenging (as well as inefficient) to lay out such specific details at this point in time. The reality is that restoration projects often happen opportunistically – when funding, landowner willingness, and other resources align concurrently. Therefore, our intention is to outline possible milestones that will be reviewed and modified as necessary during future WRP updates.

It should also be noted that not meeting these milestones within the identified timeframes does not necessarily indicate a failure, nor does meeting them indicate an absolute success. Milestones establish metrics to evaluate progress, and if one or more is not met, it suggests a need for modifications. Short-term milestones focus on current FCD-led projects, support of other organizations' current projects, public education about NPS reduction, and identification of future potential project sites. Long-term milestones focus on long-term planning for NPS pollution reduction and future restoration projects.

Table 10. Short- (2017 – 2022) and long-term (2017 – 2032) milestones for determining progress in achieving water quality standards.

Issue	Milestone
Riparian habitat degradation	**Short-term:** • Install 1-3 miles of riparian fencing. • Restore 2-5 miles of river bank (riparian habitat). • Protect 500 – 1,000 acres of riparian habitat through conservation easements. • Install 1-3 offsite or water gap livestock watering structures. • Discussed riparian degradation issues with 30 key landowners along impaired reaches or streams of concern. **Long-term:** • Increase native woody riparian vegetation along impaired stream reaches by approximately 1/3 (this seems like a reasonable goal given typical landowner willingness and availability of resources. Includes impaired streams and streams of concern with significant riparian degradation. This milestone will benefit riparian habitat, and improve temperature, sediment, and nutrient issues.
Sediment loading	**Short-term:** • Krause Creek Restoration Project: Reduce sediment loading by 100 tons/year • Haskill Creek Culvert Replacement Project: Reduce sediment loading by 50 tons/year • Identify at least one priority sediment-reducing project site along each impaired stream **Long-term:** • Buffalo Hills Streambank Restoration Project: Work with Buffalo Hills Golf Course and neighboring landowners to come up with solutions for streambank erosion along the Stillwater River. • Complete one sediment-reducing project (e.g. bank stabilization or riparian planting) every 2 years in collaboration with various partners and landowners (dependent on project location) • Reduce sediment loading by 31% for Upper Ashley Creek, 32% for Middle Ashley Creek, 34% for Lower Ashley Creek, 99% for Coal Creek, 14% for Haskill Creek, 0.2% for Logan Creek, 0.2% for Sheppard Creek, and 3% for Stillwater River* • Work with USFS Flathead National Forest to delist Logan Creek and Sheppard Creek due to current low impact of sediment loading and past BMP implementation ***Percentages derived from Flathead-Stillwater TMDL expected load reductions**

Issue	Milestone
Nutrient loading	**Short-term:** • Estimate nutrient load reductions for nutrient-reducing BMPs on a site by site basis • Identify at least one priority nutrient-reducing project site along each impaired stream **Long-term:** • Complete one nutrient-reducing project every 2 years in collaboration with various partners and landowners (dependent on project location) • Reduce number of algae blooms in impaired streams (specifically Ashley Creek). Determined on an observational basis. • Reduce TN loading by 28% for Upper Ashley Creek, 67% for Middle Ashley Creek, 91% for Lower Ashley Creek, and 53% for Spring Creek* • Reduce TP loading by 17% for Middle Ashley Creek, 58% for Lower Ashley Creek, and 68% for Spring Creek* ***Percentages derived from Flathead-Stillwater TMDL expected load reductions**
Temperature/low-flow alterations	**Short-term:** • Repair or replace 1-2 water diversion structures on each impaired stream • Identify at least one priority temperature-reducing project sites along each impaired stream **Long-term:** • Complete one temperature-reducing project every 2 years in collaboration with various partners and landowners (dependent on project location) • Increase average daily shade on Ashley Creek to 10% for stream reaches with potential for open/pasture riparian vegetation, 64% for stream reaches with potential for dense riparian vegetation, and 79% for stream reaches with the potential for forested riparian vegetation and increase average daily shade to 47% for impaired reaches on the Whitefish River* • Achieve an overall declining trend in maximum water temperatures. ***Percentages derived from Flathead-Stillwater TMDL, compare to current percentages from Attachment EC of TMDL**
Community NPS pollution education and participation in NPS pollution BMPs	**Short-term:** • Hold 1-2 workshops, activities, tours, or meetings a year on issues addressed in WRP • Hold one community meeting for each impaired stream and stream of concern to discuss WRP, NPS pollution issues, and receive feedback about problem areas along each stream. • 10 new landowners reached for each impaired stream through site visits and community meetings, and 50% of those landowners interested in implementing NPS pollution reducing BMPs • 600-1,000 students reached per year through activities on issues addressed in WRP • 30-40 teachers trained in NPS pollution and other watershed-related issues addressed in WRP • Update FCD website monthly with new information about events, NPS pollution, and other watershed-related issues

Issue	Milestone
Community NPS pollution education and participation in NPS pollution BMPs	**Long-term:** • Regular use of Flathead Watershed Sourcebook curriculum in Flathead Valley schools annually • Develop a volunteer Stream Team to assist with stream monitoring on each impaired stream
Partnership coordination, development, and support	**Short-term:** • Develop a Krause Creek Watershed Group and support initial natural resources assessment of Krause Creek • Develop a Watershed Restoration Plan Committee with representatives from FCD, FBC, FRC, FWP, Flathead Lakers, R2L, USFS FNF, and other local stakeholders. Meet with this committee once every two years to identify new issues, successes, and changes that need to be made. • Support 3-5 applications to the Section 319 funding program and 2-3 applications to other funding programs for NPS pollution reducing projects **Long-term:** • Continue bi-annual meetings with Watershed Restoration Plan Committee • Continue support of applications to Section 319 funding program and to other funding programs for NPS pollution reducing projects

8.2 Identifying a Monitoring Plan

Monitoring is necessary in adaptive management to assess progress toward intended outcomes. Monitoring can occur at several scales, so it is important that objectives are scaled appropriately. Each monitoring plan should consider project objectives, timeframe, and methods to determine extent that objectives have been met.

FCD staff and partners can conduct non-technical monitoring, such as photo plots and landowner surveys, while contracted professionals or technical partners may conduct more technical monitoring. Volunteers can be used to conduct both non-technical and some technical monitoring activities. The type of monitoring needed will depend on the project or program purpose and its intended outcome. Effectiveness monitoring can be applied to assessing riparian habitat, sediment, temperature, nutrient, E&O, and partner collaborations (Table 11). Monitoring for project effectiveness will be organized by the managing partner prior to a project and shortly after. Monitoring will continue at appropriate intervals based on project objectives.

Table 11. Examples of monitoring techniques that could be used to measure effectiveness of projects and programs that address NPS pollution issues.

Issue	Monitoring Techniques
Riparian Habitat	Photo points; in-field measurements of riparian vegetative cover; survival and establishment assessments of planted woody riparian species; frequency of noxious weed species in quadrants; band transects to monitor density or plantings
Sediment	In-field measurements (pebble counts, bank pins, width:depth ratios, physical bank measurements); photo points
Nutrients	Water sampling for total nitrogen and total phosphorus; photo points assessing algae blooms; sampling for chlorophyll-a
Temperature	Track temperature via USGS, USFS, and/or FWP gauges; sample stream flow, temperature, and dissolved oxygen at project sites; riparian shade assessments
Education & Outreach	GIS map creation to identify landowners on potential project sites and to assist with targeted outreach; pre- and post-evaluations at workshops and community meetings to understand audience connections to NPS pollution and monitor effectiveness of knowledge transfer during event; landowner interviews to measure landowner attitudes and beliefs; phone, online, or mailed questionnaires or surveys to understand community knowledge; attendance tracking at E&O events for attendance numbers and to understand what type of community members are interested
Partner Collaborations	Track partner projects and programs through regular meetings

In addition to monitoring of individual projects, FCD will track implementation of projects toward meeting short-term milestones. The preliminary aerial assessment, proposed ground-truthing, and landowner contacts will be the basis for this tracking. As part of this effort, we will undertake efforts to quantify riparian degradation across the watershed. By identifying the current state of riparian health across the watershed, FCD will be able to assess improvement (or degradation) over time, specifically related to short term milestones from Table 10. Monitoring of improvements will be conducted through aerial assessments and on the ground sites visits to rate current riparian conditions. The goals of FCD's tracking system are two-fold: 1) to facilitate monitoring for criteria/indicators associated with specific issues (Table 9), and 2) to document and coordinate landowner outreach, engagement, and individual concerns. Watershed partners will be critical to ongoing monitoring and tracking accomplishments.

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Section 10: Appendices

Appendix A: 319 Funded Projects Since 2002
Appendix B: Best Management Practices
Appendix C: AIS Management Measures from the 2016 Flathead Basin AIS Strategic Prevention Plan
Appendix D: GIS Map of Potential Project Areas Based off of Aerial Analysis
Appendix E: Example Landowner Letter
Appendix F: Example Community Input Meeting Agenda
Appendix G: Temperature Sampling Sites on Ashley Creek & Whitefish River (Flathead-Stillwater TMDL)
Ap**pendix H:** Examples of Streambank Restoration Techniques

Appendix A - Since 2002, 27 DEQ 319 grants have been provided to the Flathead-Stillwater watershed to provide funding for restoration, groundwater and education/outreach activities. Descriptions of the projects listed below can be found in the *319 Grant Summaries with Maps FY2002 – FY 2011* or in the *Montana Nonpoint Source Program Annual Reports (2012, 2013, 2014 and 2015).*

Project Name	Type	Sponsor	Funds Received	Year Requested
Flathead Ripples of Change II	Restoration	Flathead Lakers	$35,000	2015
Ripples of Change for Flathead's Critical Lands and Lakeshore	Restoration	Flathead Lakers	$50,000	2012
Flathead Lakeshore Water Quality Protection	Restoration	Flathead County	$123,000	2011
Haskill Creek – Reimer Reach Floodplain Renovation	Restoration	Flathead Conservation District	$30,000	2011
Bigfork Storm Water Project	Restoration	Flathead County	$200,000	2010
Flathead watershed Best Management Practices Education	Education & Outreach	Flathead Lakers	$40,000	2010
Bigfork Storm Water Project II	Restoration	Flathead County	$125,000	2009
Flathead TMDL Coordination	TMDL	Montana DNRC/ Flathead Basin Commission	$15,000	2009
Flathead TMDL E&O	TMDL	Flathead County	$20,000	2009
Bigfork Storm Water Project	Restoration	Flathead County	$60,000	2008
Groundwater Monitoring in Flathead Basin	Groundwater	Flathead Basin Commission	$25,000	2008
Riparian Buffer Education Campaign	Education & Outreach	Flathead Conservation District	$120,000	2008
Critical Lands E&O Project	Education & Outreach	Flathead Lakers	$35,000	2008
Flathead/Stillwater TMDL	TMDL	Flathead Conservation District	$40,000	2008
Haskill Basin Bridge & Restoration	Restoration	Flathead Conservation District	$25,000	2007
Critical Land Project	Education & Outreach	Flathead Lakers	$10,000	2007
Flathead Water Quality Protection	TMDL / Restoration	Flathead Basin Commission/ DNRC	$19,000	2006
Coal Creek Restoration Project	Restoration	Flathead Basin Commission	$26,000	2005
Haskill Basin TMDL	TMDL	Flathead Conservation District	$27,975	2005
Swift Creek TMDL	TMDL	Whitefish County Water & Sewer District	$25,234	2005
Critical Lands Project	Education & Outreach	Flathead Lakers	$30,350	2004
Haskill Basin Restoration	Restoration	Flathead Conservation District	$34,000	2003

Project Name	**Type**	**Sponsor**	**Funds Received**	**Year Requested**
Swift Creek Restoration	Restoration	Whitefish County Water & Sewer District	$60,000	2003
Flathead-Stillwater, Whitefish & Ashley	Restoration	Flathead Basin Commission	$172,370	2003
Haskill Basin Watershed Project	TMDL	Flathead Conservation District	$50,000	2002
Swift Creek watershed Project	TMDL	Whitefish County Water & Sewer District	$45,000	2002
Stillwater River Basin TMDL Project	TMDL	MT DNRC / Flathead Basin Commission	$115,884	2002

Appendix B - Identified BMPs for human-caused sources of pollutants in the Flathead-Stillwater watershed (Table adapted and adjusted from 2012 Montana NPS Management Plan (DEQ, 2012)). *This is not an exhaustive list. *

Best Management Practice	Description	Pollutant				Consultant or Engineer Needed? Y/N/?
		Nitrogen	Phosphorus	Sediment	Temperature	
Agriculture						
Clean Water Diversion	Berms, raingutters, rain barrels, roofing, reservoirs, infiltration basins, vegetated strips, or other structures used to prevent clean runoff or precipitation from picking up pollutants.	X	X	X	X	?
Corral / Pen Relocation	Moving part or all of an animal confinement facility to prevent or reduce inundation and subsequent off-site transport of pollutants.	X	X	X	X	N
Stream Crossing	A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.		X	X		?
Off-Stream Watering Facility	A permanent or portable device to provide an adequate amount and quality of drinking water for livestock and wildlife to discourage livestock from obtaining water directly from surface water body.	X	X	X	X	N
Filter Strip	A strip of permanent, perennial vegetation placed on the downgradient edge of an agricultural area to slow down surface runoff and filter out particulate matter and absorb nutrients. Vegetation should be periodically harvested if using for nutrient absorption.	X	X	X	X	N
Forage Utilization / Livestock Distribution	Rotational grazing, cross-fencing, watering facility development and other techniques designed to promote uniform forage utilization and nutrient deposition, which then leads to more vigorous plant growth and nutrient uptake, as well as reduced soil erosion and pollutant runoff.	X	X	X	X	?
Water Gap	A controlled access point from which livestock can obtain drinking water directly from a waterbody.	X	X	X	X	N
Riparian Fencing	Fencing used to permanently or temporarily control livestock access to riparian areas. Fencing may be used to prevent streambank trampling, reduce nutrient and pathogen pollution, or promote vegetative growth and plant species diversity.	X	X	X	X	N
Heavy Use Area Protection	The stabilization of areas frequently and intensively used by people, animals, or vehicles by establishing vegetative cover, by surfacing with suitable materials, and/or by installing structures.	X	X	X		?
Grazing Management Plan	A plan describing how livestock grazing will occur on a particular property or set of properties. The plan must identify the stocking density, season, duration and location of grazing activities on a field by field basis. The plan must contain a map in which all fields, watering facilities, heavy use areas, surface waters, riparian buffers, fence lines and other pertinent structures are labeled.	X	X	X	X	Y

Best Management Practice	Description	Pollutant				Consultant or Engineer Needed? Y/N/?
		Nitrogen	Phosphorus	Sediment	Temperature	
Livestock Protection	Permanent shelter structures to protect livestock from weather. The purpose of the structure would benefit water quality (e.g. a replacement for shelter previously provided by riparian vegetation).	X	X	X	X	N
Conservation Cropping/Tillage Practices	Using practices such as cover crops, conservation tillage, alley cropping, windbreaks, contour farming, and strip cropping. All of these practices assist with reducing erosion and phosphorous runoff into streams and two of these practices (cover crops and windbreaks) also help with reducing nitrogen runoff.	X	X	X		N
Irrigation Conservation Practices	Repair or replacement of structures designed to divert surface water for the purpose of watering crops or livestock. Adding an impermeable liner to an unlined irrigation canal or replacing an irrigation canal with an underground pipe. Conversion from one type of irrigation system to another, resulting in significant improvements to water quality. Structures, vegetation, or managerial controls designed to prevent sediment, nutrient, or temperature pollution from irrigation tailwater.	X	X	X	X	Y
Grassed Waterway	A shaped or graded channel that is permanently vegetated, and is designed to convey water at a nonerosive velocity to a stable outlet. The vegetation in the channel must be capable of withstanding periodic inundation, as well as the expected erosive forces associated with foreseeable flow events.		X	X		?
Waste Utilization	Storing, transporting and using agricultural wastes such as manure, wastewater, and organic residues in a manner that reduces nonpoint source pollution. Also includes equipment necessary in order to insure proper waste transfer and utilization (e.g. small manure spreaders).	X	X			?
Riparian Buffer	A strip of perennial vegetation located adjacent to, and up gradient, from a waterbody. Buffer width, slope, species composition and target pollutants must be considered in the design.	X	X	X	X	?
Composting Facility	A facility to process raw manure or other raw organic by-products into biologically stable organic material. The facility must be designed to prevent run-off or infiltration from nutrients and/or bacteria.	X	X			Y
Revegetation	Establishing permanent vegetative cover in order to prevent soil erosion. Where appropriate, revegetation efforts should focus on establishing native vegetation communities matched to site-specific resource goals and conditions.	X	X	X	X	Y
Nutrient Management Plan	A plan describing how plant nutrients will be managed in order to prevent nonpoint source pollution. The plan must identify the amount, source, placement, form and timing of all nutrient applications on a given farm or set of farms.	X	X			Y
Erodible Land Conversion	Conversion of highly erodible lands to permanent vegetative cover.	X	X	X		N

Best Management Practice	Description	Pollutant				Consultant or Engineer Needed? Y/N/?
		Nitrogen	Phosphorus	Sediment	Temperature	
Hydrologic Function Restoration	Alterations made to groundwater or surface water hydrology or channel morphology in order to reestablish hydraulic connectivity, groundwater elevation, stream flow, wetland function, stream channel function, or other waterbody attributes that were once eliminated in order to facilitate agricultural production.	X	X	X	X	Y
Urban/Stormwater						
Setbacks and Zoning	Laws and ordinances limiting or prohibiting certain activities adjacent to streams, lakes, floodplains, and/or wetlands.	X	X	X	X	Y
Pet Waste Management	Removal and disposal of pet excrement, kitty litter, and soiled bedding materials to prevent them from entering surface water or groundwater.	X	X			N
Septic System Maintenance	Regular inspection and cleanout of onsite wastewater treatment systems (septic systems). Repair of leaking or otherwise malfunctioning components.	X	X			Y
Storm Drain Inlet Protection	Installation of grates to catch large debris. Regular cleanout of storm drain inlets. Onsite posting of information regarding storm drains discharges (e.g. a stenciled label stating "Drains to fish stream").	X	X	X		N
Lawn and Garden Conservation Practices	Management of amount, placement and timing of fertilizer applications to minimize off-site transport and deep percolation of nutrients and adjusting amount, timing and placement of irrigation water to prevent excess surface runoff and leaching of nutrients and pesticides below the root zone. Choose plant varieties that require less water.	X	X	X	X	N
Construction Site Stormwater Runoff Control	Silt fences, straw waddles, clean water diversions, sediment settling basins, road maintenance, mulching, and other practices designed to prevent water from entering or exiting a construction site.	X	X	X		?
Hookup Failing Septic Systems to Sanitary Sewer	Decomissioning of failing septic systems and hookup to a sanitary sewer system. Sanitary sewer (e.g. municipal wastewater systems) may offer a higher level of treatment.	X	X			Y
Parking Lot and Road Cleanup	Regular removal and safe disposal of sand, trash, and other accumulated materials from parking lots.			X		N
Permeable Landscaping	Installation and maintenance of parks, permeable pavement, public gardens, and other forms of landscape that allow gradual percolation of precipitation and reduce concentrated runoff flow.	X	X	X	X	?
Preservation of Existing Vegetation	Preservation of existing riparian vegetation.	X	X	X	X	N

Best Management Practice	Description	Pollutant: Nitrogen	Phosphorus	Sediment	Temperature	Consultant or Engineer Needed? Y/N/?
Conservation Easements	Establishing legally binding restrictions, attached to a piece of real estate, that either temporarily or permanently limit the activities that may take place, in order to prevent NPS pollution.	X	X	X	X	Y
Illicit Dumping Investigation and Cleanup	Identification, assessment and cleanup of illicit dump sites. Practice may include dump sites for waste, hazardous waste, animal/human fecal matter, or other substances that could be a source of NPS pollution.	X	X			?
Stormwater Reuse Systems	Practices such as rain gardens, rain barrels, constructed wetlands, vegetated swales, and filter strips designed to contain, treat and/or reuse stormwater that might otherwise carry pollutants to streams.	X	X	X		Y
Settling Basins or Sediment Traps	Constructed pits, depressions, straw wattles, silt fences or other containment devises used to trap or settle out sediment from urban runoff. These structures must be periodically cleaned out in order to maintain function.		X	X		N
Composting	Composting and subsequent reuse of organic waste.	X	X			N
Transportation						
Road Sand Management	Judicious application and prompt removal of road traction sand to prevent release of sand into surfacewater, while still providing traction necessary to ensure public safety.			X		Y
Road Repair and Maintenance	Timely repair of water bars, sediment traps, road ditches, culverts, and other runoff control structures.		X	X		Y
Travel Management Plans	Develop and implement comprehensive travel management plans to limit NPS pollution from transportation networks and to limit disturbance of riparian areas.		X	X	X	Y
Off-Highway Vehicle (OHV) Management	Developing, designating, and maintaining trails for OHV recreation. Trails should be designed to avoid OHV contact with surface water and riparian areas or to limit contact to hardened crossings or bridges.		X	X		N
Road Crossing	Site, design and construct bridges, culverts, hardened crossings, and fords to prevent the disruption of stream sediments, erosion of stream banks, removal of large amounts of riparian vegetation, and excessive bridge deck runoff.		X	X	X	Y
Road Grading	Rut removal, grade control, and other techniques to prevent road runoff that can lead to erosion.		X	X		Y
Road Relocation	Relocate roads outside of riparian areas and floodplains.		X	X	X	Y
Road Obliteration or Decommission	Removal or decommissioning of roads that have been significant sources of NPS pollution.		X	X		Y

Best Management Practice	Description	Pollutant: Nitrogen	Phosphorus	Sediment	Temperature	Consultant or Engineer Needed? Y/N/?
Disturbed Soil Roughening	Roughening of disturbed soil to temporarily discourage concentrated runoff.		X	X		N
Settling Basins or Sediment Traps	Constructed pits or depressions used to trap or settle out sediment from road runoff. These structures must be periodically cleaned out to maintain function.		X	X		N
Recreation						
Public Boat Ramps and Fishing Access	Establish and maintain boat ramps and fishing access sites that allow the public access to streams and lakes, while discouraging creation of individual user trails through riparian areas.			X	X	Y
Public Trails	Establish and maintain a system of trails in and through riparian areas. Trails should be sited and constructed to prevent erosion and control runoff from the trail surface.			X		N
Remove "Unofficial" Trails	Obliterate or restrict access to trails that generate significant amounts of NPS pollution or cause excessive damage to riparian areas			X	X	N
Waste Handling and Disposal	Provide toilets and trash cans to encourage proper waste disposal.	X	X			N
No-wake Zones	Establish and enforce no-wake zones to protect fragile shorelines from erosion.			X		N
Off-Highway Vehicle (OHV) Management	Developing, designating, and maintaining trails for OHV recreation. Trails should be designed to avoid OHV contact with surface water and riparian areas or to limit contact to hardened crossings or bridges.			X		N
Stream Restoration						
Streambank stabilization, stream habitat restoration	Stream restoration practices will be identified and applied on a site-specific basis. Emphasis will be given to BMPs that restore natural, self-perpetuating stream processes and cost-effective controls.	X	X	X	X	Y
Forestry						
Forest Road Maintenance	Minimize number of roads constructed in a watershed through road planning, fit road to topography by locating roads on natural benches and following natural contours. Make sure design and drainage of roads are up-to-date. Grade road surfaces as often as necessary to maintain stable running surface and adequate surface drainage. Haul excess material removed to safe disposal sites.		X	X		Y
Timber Harvesting	Plan timber harvest in consideration of set management objectives and other natural conditions.	X	X	X	X	Y

Best Management Practice	Description	Pollutant: Nitrogen	Pollutant: Phosphorus	Pollutant: Sediment	Pollutant: Temperature	Consultant or Engineer Needed? Y/N/?
Stream Crossing Development and Maintenance	Obtain needed permitting. Minimize stream channel disturbances during construction of road and installation of stream crossing structures. Install culverts to prevent erosion of fill. Ensure stream crossing culverts have adequate length to allow for road fill width and are maintained.		X	X		Y
Miscellaneous BMPs						
Wetland Restoration or Creation	Restoration, re-creation or enhancement for the purpose of addressing NPS pollution.	X	X	X	X	Y
Revegetation	Planting, protecting or reestablishing permanent vegetative cover in riparian or upland areas. Practice may include seeding, sprigging, shrub planting, fencing to protect emerging or fragile vegetation, willow lifts, sod mats, overseeding, nonnative plant removal, native plant reintroduction, riparian buffer creation, and replacement of annual plants with perennial vegetation.	X	X	X	X	?
Floodplain Reestablishment	Reestablishment of a stream's floodplain or reconnection to an abandoned floodplain. May include breaching, removal, or modification of dikes or levees.	X	X	X	X	Y
Culvert Maintenance	Removal or replacement of culverts to reduce NPS pollution.		X	X		Y
Dam Removal or Modification	Dam removal or modification to restore the natural hydrograph of a stream in order to facilitate natural stream processes that would reduce NPS pollution.			X	X	Y
Educational Events	Educational events such as educational tours, field days, trainings, conferences, and workshops designed to raise awareness of NPS pollution or train people on how to address NPS pollution.	X	X	X	X	N
Educational Materials	Educational materials such as brochures, newsletters, fliers, mailings, listserves, webpages and blogs designed to raise awareness of NPS pollution or train people on how to address NPS pollution.	X	X	X	X	N
Media Campaigns	Television, radio, internet or other media campaigns to raise awareness of NPS pollution or train people on how to address NPS pollution.	X	X	X	X	Y
Service Learning	Hands-on training and experience in techniques to address NPS pollution.	X	X	X	X	?
Social Networking	Use of social networking to raise awareness of NPS pollution issues or train people on how to address NPS pollution.	X	X	X	X	N
Special Area Management Plan	Management plans designed to help prevent NPS pollution in sensitive or threatened landscapes or watersheds.	X	X	X	X	Y
Mulching	Application of organic materials to bare or highly erodible soils to prevent erosion.		X	X		N

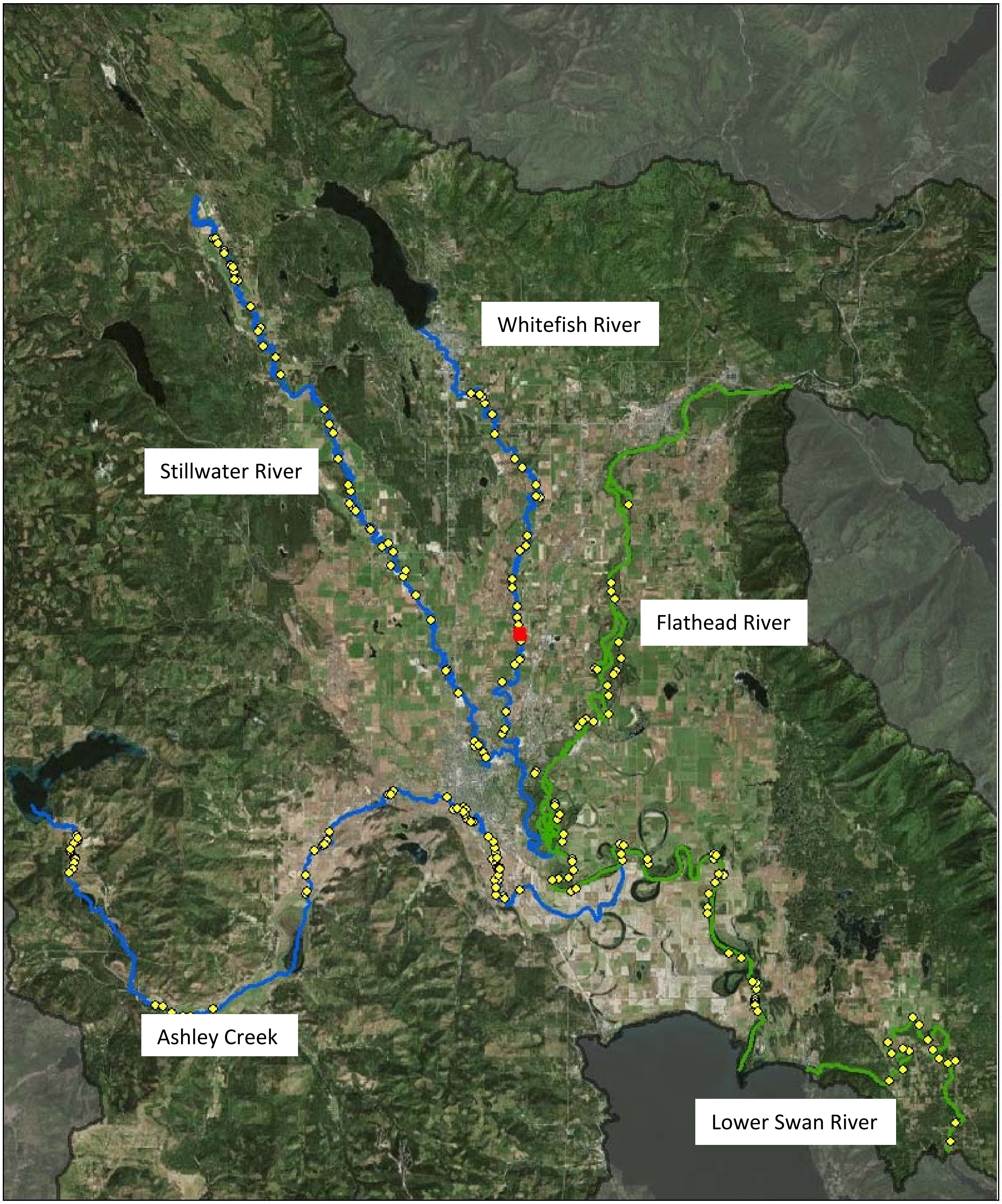
Appendix C - 2016-2020 AIS action items derived from the 2016 Flathead Basin AIS Strategic Prevention Plan (FAISWG, 2016)

Action Items for 2016	
Prevention	• Ensure that all major roadways into the Flathead Basin have mandatory watercraft inspection stations. • In addition to Work Group members, Montana partners may include MDOT. • Coordinate, through the Crown Managers Partnership with Canadian partners to facilitate perimeter defense for the Crown of the Continent ecosystem. • Encourage longer hours of operation, earlier season and two-way stopping at watercraft inspection stations. • Enhanced enforcement to increase compliance rates/reduce drive-bys. • Operate volunteer watercraft inspection stations at boat launches in the Flathead Basin. • Create and support legislation, regulations and/or ordinances that prevent the introduction of AIS to the Flathead Basin and Montana. • Partner with local Law Enforcement agencies to ensure existing AIS laws are upheld in the Flathead Basin. • Create an effective "Flathead First Alert" system to ensure boats with AIS heading to the Flathead or the Blackfeet Reservation are intercepted and decontaminated.
Monitoring	• Continue to implement the AIS Monitoring Plan in the Basin. Meet with partners at the beginning of the field season to: o Ensure that all monitoring entities are familiar with the protocols; reduce duplication of efforts; confirm water bodies to be monitored and frequency rate; ensure any pertinent data gaps are filled; and modify the plan when necessary. • Use, develop, or modify existing universal/consistent survey methodologies for basin-wide use. • Continue to support and obtain funding for professional AIS monitoring services and rapid assessments. • Continue to support volunteer monitoring efforts including but not limited to: CRC, WLI and Swan Lakers. • Recruit new organizations to start monitoring programs.
Rapid Response	• Undertake comparative analysis of Rapid Response Plans, including those of the Western Regional Panel, provinces and nearby states, to assist in crafting a Flathead Basin Rapid Response Plan. • Ensure framework is established to enact Rapid Response when needed (includes boat ramp closure signs, emergency funding, and public outreach).
Containment and Mitigation	• Annually review and update as needed, Aquatic Invasive Plant Plan. • Develop mitigation plans for existing and newly discovered AIS infestations. • Facilitate discussion amongst responsible management agencies to better coordinate and fund mitigation efforts.
Education and Outreach	• Establish relationships with visitor centers, chambers of commerce and other "marketing focal points," such as websites. • Promote 1-on-1 contact with water users. • Implement school outreach programs. • Integrate AIS outreach into the plans and actions of partner and other relevant agencies and organizations.
Research	• Research AIS characteristics, mitigation methods and introduction pathways. • Research impacts of AIS, including social, ecological and economic systems. • Conduct local focus group testing for AIS messaging.
Innovation for the Future	• Create a strategy for effectively identifying, assessing and managing boats with ballast tanks.

Action Items for 2017 to 2020	
Prevention	• Use of AIS detection dogs. • Create and support legislation, regulations and/or ordinances that prevent the introduction of AIS to the Flathead Basin and Montana. • Identify less common AIS vectors and ensure they are AIS free.
Monitoring	• Use existing databases/maps as templates to incorporate new survey data when available. Develop a basin-wide AIS database/map if needed. • Offer mussel substrates to groups to enhance public participation.
Rapid Response	• Establish a sub-committee within the Work Group to create the Basin-wide Response Plan. • Implement an early detection and rapid response system. • Develop an improved notification structure within the Flathead Basin. • Define authorities and responsibilities in a rapid response scenario that includes plants, animals and pathogens. • Create easy-to-follow rapid response protocols for plants, animals and pathogens. • Coordinate a Table Top exercise for the Flathead Basin Work group and modify the Rapid Response Plan as necessary.
Containment and Mitigation	• Complete a Programmatic Environmental Impact Statement for the Flathead Basin for the use of different control measures, including herbicides. • Develop Standard Operating Procedures (SOPs) for long term containment for newly discovered AIS infestations (plants, mussels, other…).
Education and Outreach	• Use the data collected from Section 6: Research to develop a AIS Campaign/Marketing Plan. • Create and implement an AIS Certification Program. • Define and incorporate Best Management Practices into water user activities. • Promote a consistent and effective education and outreach campaign.
Research	• Use results from focus group testing to create effective AIS messaging and an outreach plan/call to action. • Inventory completed and on-going AIS research in the Basin, state, and nation.

Appendix D – Future potential project areas based off of aerial analysis.

Google Earth was used to identify areas with limited riparian vegetation or streambank erosion along five streams (Ashley Creek, Stillwater River, Whitefish River, Flathead River, and Lower Swan River). Ground truthing and landowner outreach should be conducted to identify potential project sites from this initial assessment. The red box in the map below corresponds to the close-up map on the following page. The latter is an example of a potential project site (WH21) and the relevant data collected.



Data collected for potential project site WH21 (Whitefish River). Data was collected by observation and aerial analysis. Landowner information was determined from the Cadastral data set from the MT GIS Portal.

Site Name	WH21
Latitude	48.269892
Longitude	-114.284847
Stream Bank Area Affected	Medium
Current Vegetation	Upland Shrub
Historical/Potential Vegetation	Riparian Shrub
Potential Revegetation Site?	High
Soil Type	Silt Loam
Erosion Type	Accelerated Streambank
Legal Description	S16, T29 N, R21 W, ACRES 20, COS 10926-7, TR 3, TR 3B, TR 3BA IN SW4, ASSR #0000228400
Subdivision	
Property Address	1320 TRUMBLE CREEK RD
Property City, State, Zip Code	KALISPELL, MT 59901
Property Type	RR - Residential Rural

Appendix E – Example Landowner Outreach Letter

Flathead Conservation District
133 Interstate Lane, Kalispell, MT 59901

Phone: 406-752-4220 Fax: 406-752-4077
www.flatheadcd.org

Date

Landowner Address

To whom it may concern,

The Flathead Conservation District (FCD) has a wide range of resources available to private landowners in Flathead County. In addition to administering Montana's Natural Streambed and Land Preservation Act (310 law), the district organizes a variety of public outreach and educational activities and supports the implementation of on-the-ground projects that help citizens conserve soil, water, and other renewable natural resources. As a private landowner, we want to make you aware of opportunities that may benefit your land and operations.

FCD provides financial assistance to private landowners who want to implement conservation practices on their property. In particular, fencing in riparian areas can serve as a win-win opportunity for both landowners and water resources. Protecting fragile stream-side vegetation from livestock trampling can facilitate the development of a healthy riparian area. In turn, riparian vegetation benefits livestock operations by offering shade and protection for the animals and anchoring the streambank to minimize property loss from erosion. Notably, grazing management strategies can be flexible to include water access (e.g., stock tanks, nose pumps, or water gaps) and partial-year access for weed control.

If you are interested in learning more about FCD's landowner assistance programs, please contact our office or visit our website (information listed above). Enclosed is some information about FCD's Cost-Share Program, which provides assistance for a wide variety of conservation projects, including riparian fencing. This year's application deadline for the Cost-Share Program is May 31st.

Additionally, we encourage you to attend a community input meeting for *stream*. In early 2017, FCD completed a Watershed Restoration Plan identifying a number of streams that are impaired for nonpoint source pollution. The next step in our process is talking with local landowners to understand where issues on the stream specifically lie, and who would be interested in participating in restoration efforts. The meeting is scheduled for *date* and we hope to see you there.

Sincerely,

Ronald Buentemeier, Chariman
Enc.:FCD brochure, NPS brochure, cost-share information

Appendix F – Example Community Input Meeting Agenda

Flathead Conservation District
133 Interstate Lane, Kalispell, MT 59901

Phone: 406-752-4220 Fax: 406-752-4077
www.flatheadcd.org

COMMUNITY INPUT MEETING FOR *stream* *date*

6 PM – Introductions

6:15 PM – What is NPS pollution?

6:30 PM – What is the Flathead-Stillwater Watershed Restoration Plan
Which streams are impaired?
What are the listed impairments for your stream?

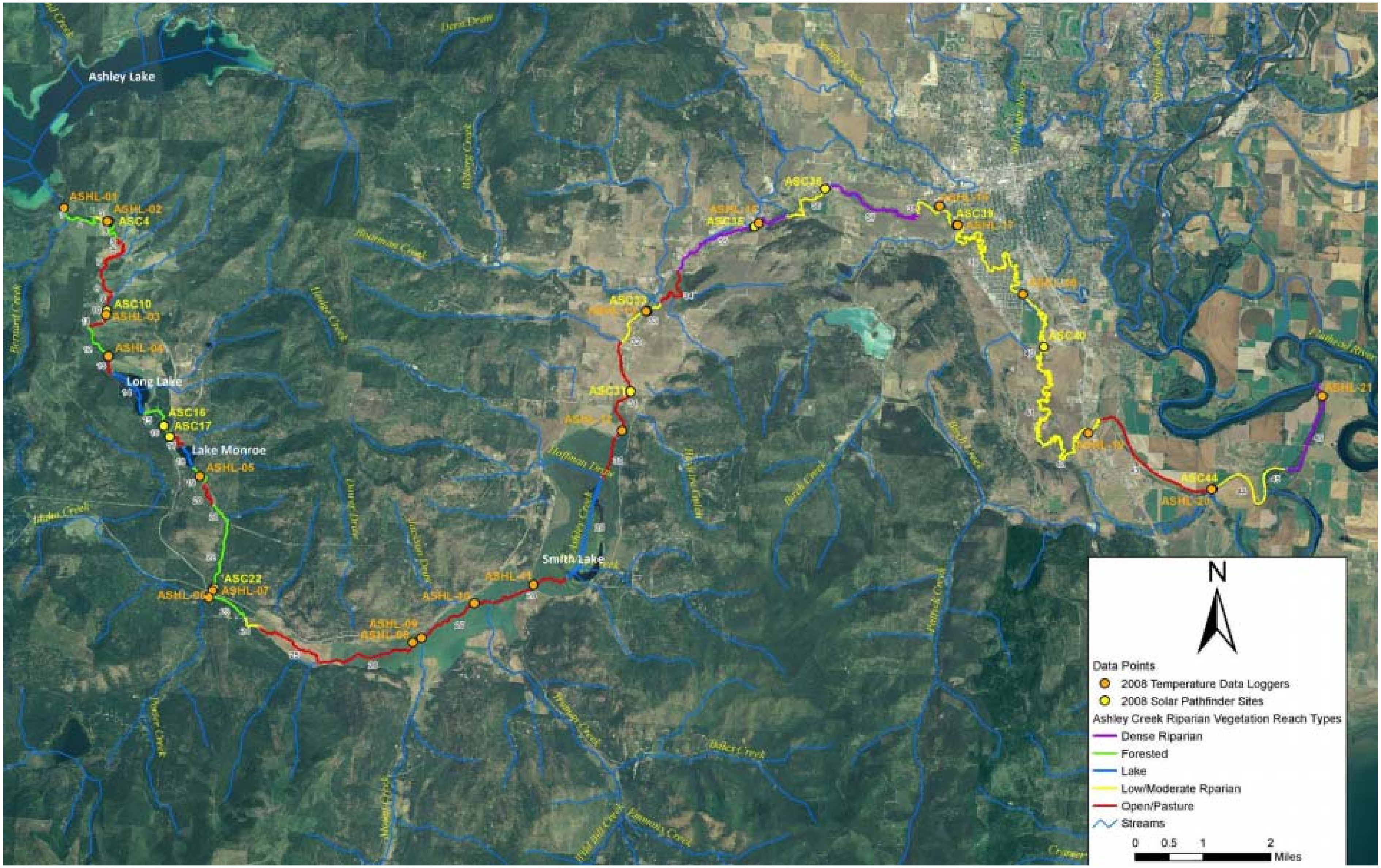
6:45 PM – Community Input

- What part of the stream are you located?
- What issues do you experience on the stream?
- What solutions do you think may help?
- Would you be interested in restoration work on your property?
- What resources do you have for restoration/what resources would you need?
- Which organization should you work with?

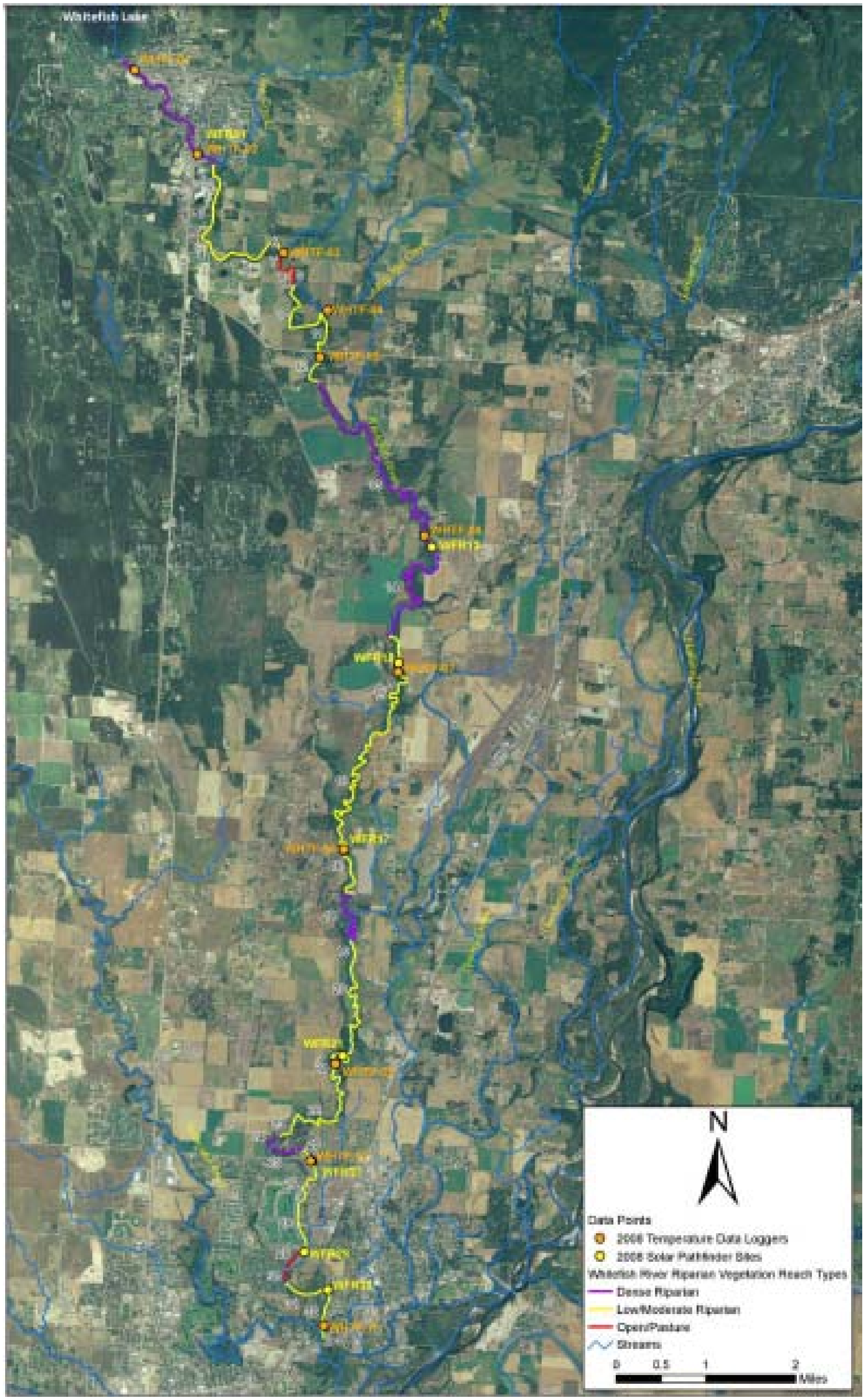
7:45 PM - Conclusion

Appendix G - Temperature data logger and Solar Pathfinder sampling sites on Ashley Creek and Whitefish River (DEQ, 2014b).

Ashley Creek

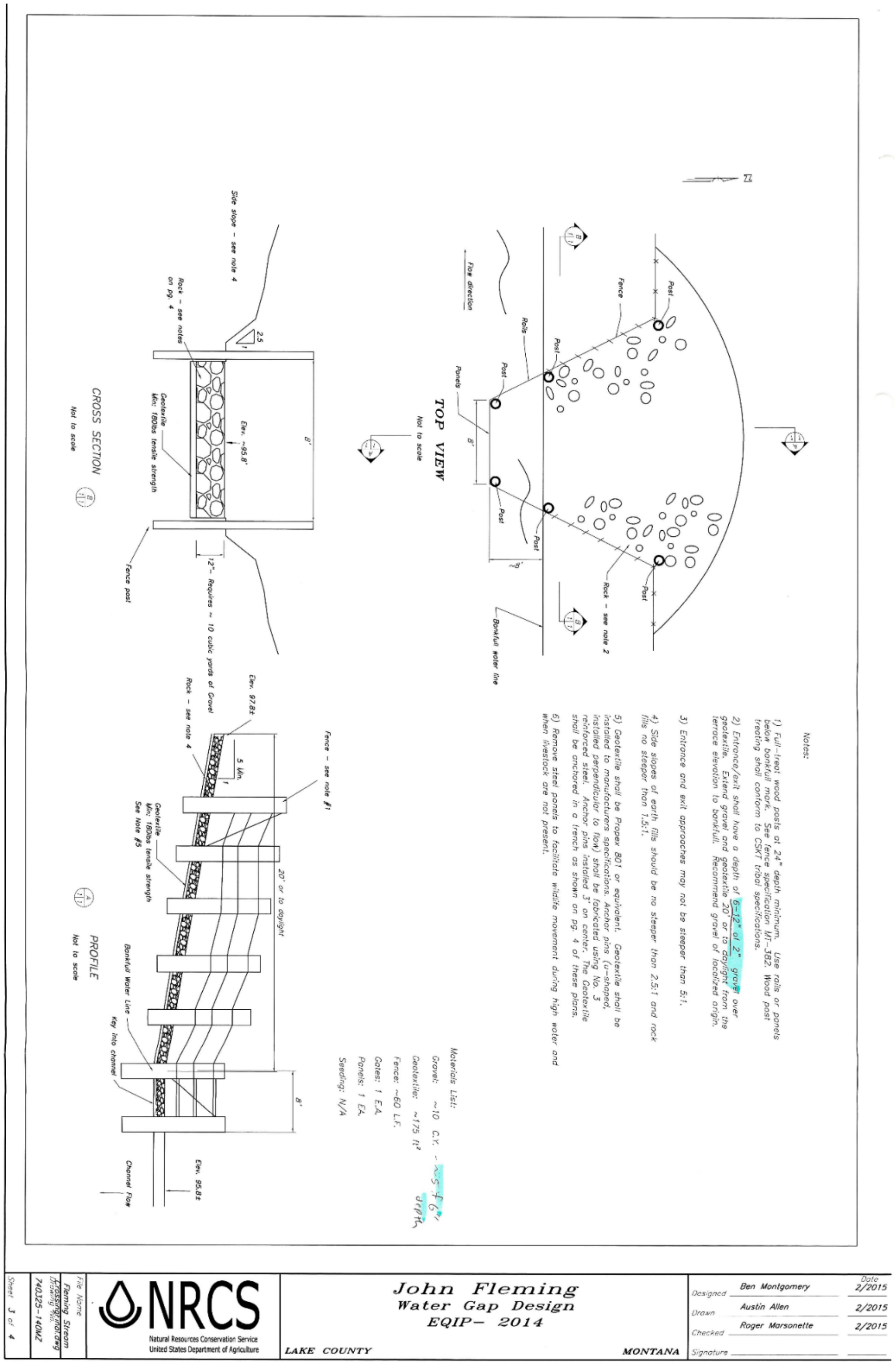


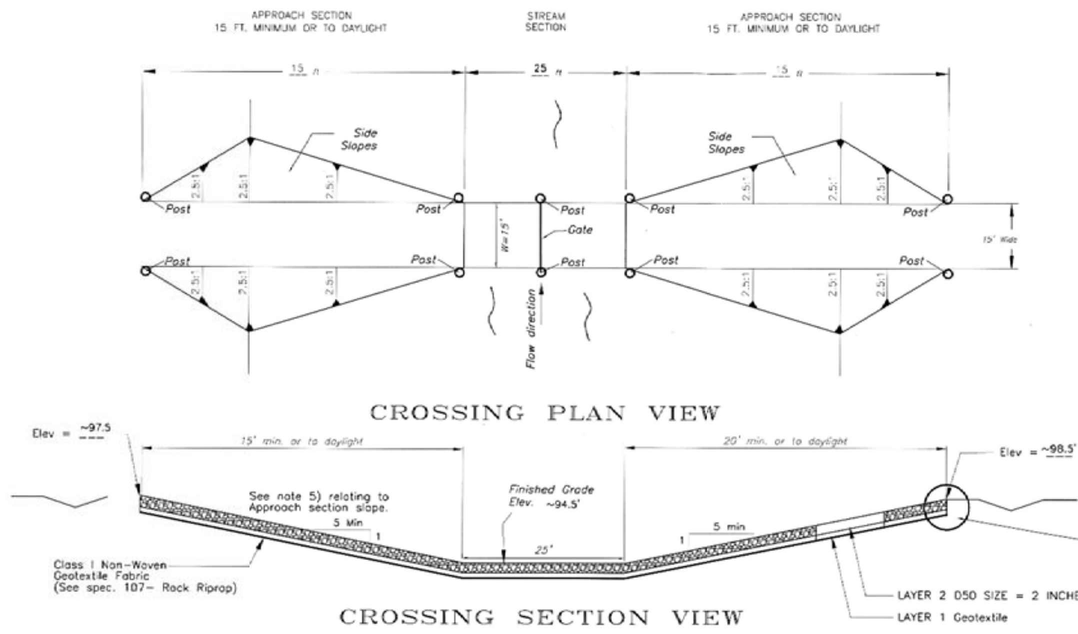
Whitefish River



Appendix H: Examples of Streambank Restoration Techniques (NRCS water gap design and example instream practices and streambank treatments from *Federal Stream Corridor Restoration Handbook* (FISRWG (10/1998)) - see this handbook for other ideas on water and watershed management. Another resource for restoration techniques is the *Montana Stream Permitting: A Guide for Conservation District Supervisors & Others,* which is currently undergoing updates.

Water Gap Design





Materials List:

Gravel: ~17 C.Y. –

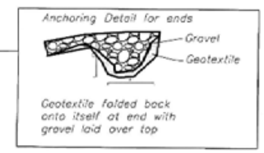
Geotextile: ~975 ft²

Fence: ~80 L.F.

Gates: 1 E.A.

Panels: 1 E.A.

Seeding: _N/A_



LAYER 1 This will be the geotextile fabric over smoothed and properly sloped ground surface. Care should be taken during placement so as not to damage the geotextile.

LAYER 2 This is the Rock Crossing Material and should be well-graded. The Gradation is based on the D50 size which is shown in the table. The layer thickness will be at least 6 inches thick of 2" D50 sized sub angular gravel.

NOTES:

1) The finished grade elevation in the stream section should be about 4 inches below the natural channel grade.

2) The minimum crossing width, W, will be 6 feet for a "livestock only" crossing. A "multi-use" crossing will have a minimum width of 10 feet and a maximum width of 20 feet.

3) Geotextile fabric shall be Propex 801 or equivalent. The geotextile will be keyed in according to the manufacturer's recommendations.

4) The slope of the approach sections should blend with existing site conditions but will not be steeper than 5:1. Side slopes shall not be steeper than 2.5:1.

5) Where necessary, surface flow diversions should be installed as shown to prevent sediment-laden runoff from entering the stream.

6) These drawings were developed using Engineering Technical Note 13, dated February 2001, as the design guide.

LAYER 2 GRADATION TABLE

% PASSING BY WEIGHT	D50 SIZE (INCHES)				
	4	3	2	1	1/2
100	8	6	4	2	1
50–85	6	4	3	1 1/2	3/4
15–50	4	3	2	1	1/2
0–15	2 1/2	2	1	1/2	1/4

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

File Name: Fleming Stream Crossing.dwg
Drawing No. 740325-140MZ
Sheet 4 of 4

John Fleming
Stream Crossing
EQIP– 2014

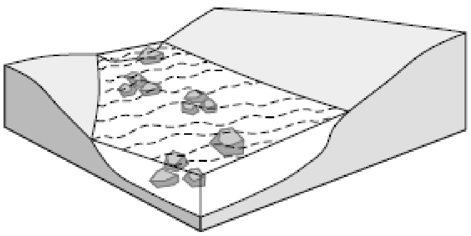
LAKE COUNTY — MONTANA

		Date
Designed	Ben Montgomery	2/2015
Drawn	Austin Allen	2/2015
Checked	Roger Marsonette	2/2015
Signature		

Instream Practices Examples– From the *Federal Stream Corridor Restoration Handbook*

*Note: Not all of these practices are practical or ecological sound (e.g., wing deflectors, vegetated gabions, riprap, and stone toe protection). Please consult with a restoration practitioner and agency partners before implementing these examples.

Boulder Clusters



Groups of boulders placed in the base flow channel to provide cover, create scour holes, or areas of reduced velocity.

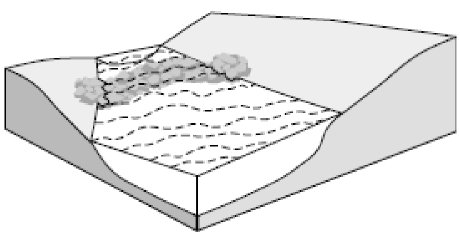
Applications and Effectiveness

- Can be used in most stream habitat types including riffles, runs, flats, glides and open pools.
- Greatest benefits are realized in streams with average flows exceeding 2 feet per second.
- Group placements are most desirable. Individual boulder placement might be effective in very small streams.
- Most effective in wide, shallow streams with gravel or rubble beds.
- Also useful in deeper streams for providing cover and improving substrate.
- Not recommended for sand bed (and smaller bed materials) streams because they tend to get buried.
- Added erosive forces might cause channel and bank failures.
- Not recommended for streams which are aggrading or degrading.
- May promote bar formation in streams with high bed material load.

For More Information

- Consult the following references: Nos. 11, 13, 21, 34, 39, 55, 60, 65, 69.

Weirs or Sills



Log, boulder, or quarrystone structures placed across the channel and anchored to the streambank and/or bed to create pool habitat, control bed erosion, or collect and retain gravel.

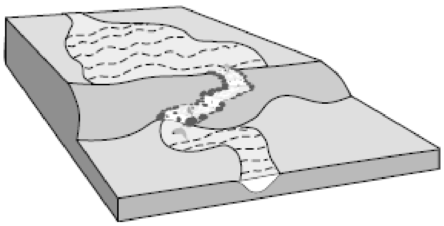
Applications and Effectiveness

- Create structural and hydraulic diversity in uniform channels.
- If placed in series, they should not be so close together that all riffle and run habitat is eliminated.
- Pools will rapidly fill with sediment in streams transporting heavy bed material loads.
- Riffles often are created in downstream deposition areas.
- Weirs placed in sand bed streams are subject to failure by undermining.
- Potential to become low flow migration barriers.
- Selection of material is important.
  - Boulder weirs are generally more permeable than other materials and might not perform well for funneling low flows. Voids between boulders may be chinked with smaller rock and cobbles to maintain flow over the crest.
  - Large, angular boulders are most desirable to prevent movement during high flows.
  - Log weirs will eventually decompose.
- Design cross channel shape to meet specific need(s).
  - Weirs placed perpendicular to flow work well for creating backwater.
  - Diagonal orientations tend to redistribute scour and deposition patterns immediately downstream.
  - Downstream "V's" and "U's" can serve specific functions but caution should be exercised to prevent failures.
  - Upstream "V's" or "U's" provide mid-channel, scour pools below the weir for fish habitat, resting, and acceleration maneuvers during fish passage.
  - Center at lower elevation than sides will maintain a concentrated low flow channel.

For More Information

- Consult the following references: Nos. 11, 13, 44, 55, 58, 60, 69.

Fish Passages



Any one of a number of instream changes which enhance the opportunity for target fish species to freely move to upstream areas for spawning, habitat utilization, and other life functions.

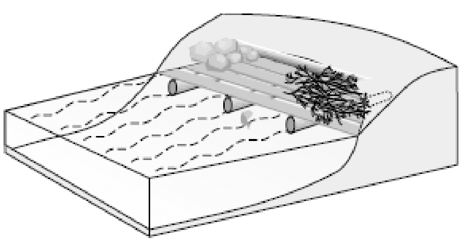
Applications and Effectiveness

- Can be appropriate in streams where natural or human placed obstructions such as waterfalls, chutes, logs, debris accumulations, beaver dams, dams, sills, and culverts interfere with fish migration.
- The aquatic ecosystem must be carefully evaluated to assure that fish passages do not adversely impact other aquatic biota and stream corridor functions.
- Slopes, depths and relative positions of the flow profile for various flow ranges are important considerations. Salmonids, for example, can easily negotiate through vertical water drops where the approach pool depth is 1.25 times the height of the (drop subject to an overall species-specific limit on height) (CA Dept. of Fish and Game, 1994).
- The consequences of obstruction removal for fish passage must be carefully evaluated. In some streams, obstructions act as barriers to undesirable exotics (e.g. sea lamprey) and are useful for scouring and sorting of materials, create important backwater habitat, enhance organic material input, serve as refuge for assorted species, help regulate water temperature, oxygenate water, and provide cultural resources.
- Designs vary from simple to complex depending on the site and the target species.

For More Information

- Consult the following references: Nos., 11, 69, 81.

Log/Brush/Rock Shelters



Logs, brush, and rock structures installed in the lower portion of streambanks to enhance fish habitat, encourage food web dynamics, prevent streambank erosion, and provide shading.

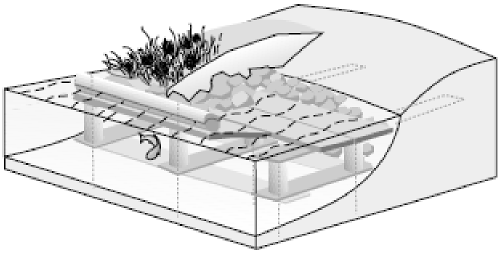
Applications and Effectiveness

- Most effective in low gradient stream bends and meanders where open pools are already present and overhead cover is needed.
- Create an environment for insects and other organisms to provide an additional food source.
- Can be constructed from readily available materials found near the site.
- Not appropriate for unstable streams which are experiencing severe bank erosion and/or bed degradation unless integrated with other stabilization measures.
- Important in streams where aquatic habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Not generally as effective on the inside of bendways.

For More Information

- Consult the following references: Nos. 11, 13, 39, 55, 65.

Lunker Structures



Cells constructed of heavy wooden planks and blocks which are imbedded into the toe of streambanks at channel bed level to provide covered compartments for fish

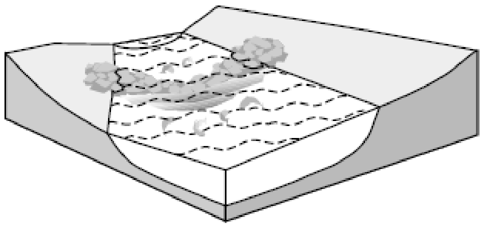
Applications and Effectiveness

- Appropriate along outside bends of streams where water depths can be maintained at or above the top of the structure.
- Suited to streams where fish habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Are often used in conjunction with wing deflectors and weirs to direct and manipulate flows.
- Are not recommended for streams with heavy bed material loads.
- Most commonly used in streams with gravel-cobble beds.
- Heavy equipment may be necessary for excavating and installing the materials.
- Can be expensive.

For More Information

- Consult the following references: Nos. 19, 60, 65, 85

Migration Barriers



Obstacles placed at strategic locations along streams to prevent undesirable species from accessing upstream areas.

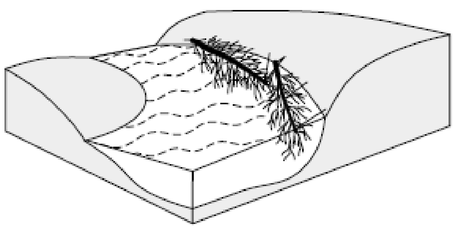
Applications and Effectiveness

- Effective for specific fishery management needs such as separating species or controlling nuisance species by creating a barrier to migration.
- Must be carefully evaluated to assure migration barriers do not adversely impact other aquatic biota and stream corridor functions.
- Both physical structures or electronic measures can be used as barriers.
  - Structures can be installed across most streams, but in general they are most practical in streams with baseflows depths under two feet and widths under thirty feet.
  - Temporary measures such as seines can also be used under the above conditions.
  - Electronic barriers can be installed in deeper channels to discourage passage. Electronic barrier employs lights, electrical pulses or sound frequencies to discourage fish from entering the area. This technique has the advantage of not disturbing the stream and providing a solution for control in deep water.
- Barriers should be designed so that flood flows will not flank them and cause failures.

For More Information

- Consult the following references: Nos. 11, 55.

Tree Cover



Felled trees placed along the streambank to provide overhead cover, aquatic organism substrate and habitat, stream current deflection, scouring, deposition, and drift catchment.

Applications and Effectiveness

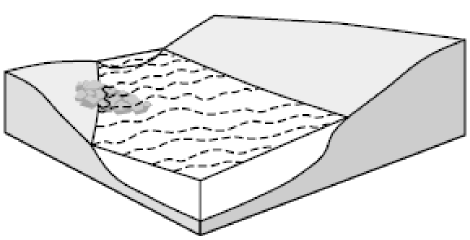
- Can provide benefits at a low installation cost.
- Particularly advantageous in streams where the bed is unstable and felled trees can be secured from the top of bank.
- Channels must be large enough to accommodate trees without threatening bank erosion and limiting needed channel flow capacity.
- Design of adequate anchoring systems is necessary.
- Not recommended if debris jams on downstream bridges might cause subsequent problems.
- Require frequent maintenance.
- Susceptible to ice damage.

For More Information

- Consult the following references: Nos. 11, 55, 69.

Wing Deflectors

S



Structures that protrude from either streambank but do not extend entirely across a channel. They deflect flows away from the bank, and scour pools by constricting the channel and accelerating flow.

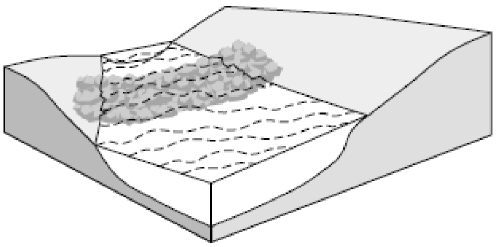
Applications and Effectiveness

- Should be designed and located far enough downstream from riffle areas to avoid backwater effects that would drown out or otherwise damage the riffle.
- Should be sized based on anticipated scour.
- The material washed out of scour holes is usually deposited a short distance downstream to form a bar or riffle area. These areas of deposition are often composed of clean gravels that provide excellent habitat for certain species.
- Can be installed in series on alternative streambanks to produce a meandering thalweg and associated structural diversity.
- Rock and rock-filled log crib deflector structures are most common.
- Should be used in channels with low physical habitat diversity, particularly those with a lack of stable pool habitat.
- Deflectors placed in sand bed streams may settle or fail due to erosion of sand, and in these areas a filter layer or geotextile might be needed underneath the deflector.

For More Information

- Consult the following references: Nos. 10, 11, 18, 21, 34, 48, 55, 59, 65, 69, 77.

Grade Control Measures



Rock, wood, earth, and other material structures placed across the channel and anchored in the streambanks to provide a "hard point" in the streambed that resists the erosion forces of the degradational zone, and/or to reduce the upstream energy slope to prevent bed scour.

Applications and Effectiveness

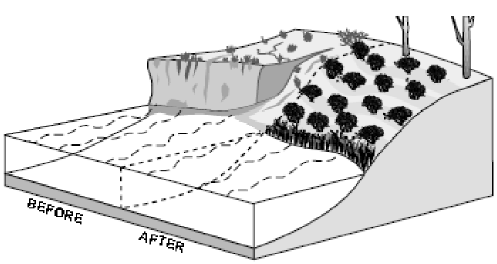
- If a stable channel bed is essential to the design, grade control should be considered as a first step before any restoration measures are implemented (if degradational processes exist in channel system).
- Used to stop headcutting in degrading channels.
- Used to build bed of incised stream to higher elevation.
- Can improve bank stability in an incised channel by reducing bank heights.
- Man-made scour holes downstream of structures can provide improved aquatic habitat.
- Upstream pool areas created by structures provide increased low water depths for aquatic habitat.
- Potential to become low flow migration barrier.
- Can be designed to allow fish passage.
- If significant filling occurs upstream of structure, then downstream channel degradation may result.
- Upstream sediment deposition may cause increased meandering tendencies.
- Siting of structures is critical component of design process, including soil mechanics and geotechnical engineering.
- Design of grade control structures should be accomplished by an experienced river engineer.

For More Information

- Consult the following references: Nos. 1, 4, 5, 6, 7, 12, 17, 18, 25, 26, 31, 37, 40, 63, 66, 84.

Streambank Treatments Examples- From the *Federal Stream Corridor Restoration Handbook*

Bank Shaping and Planting



Regrading streambanks to a stable slope, placing topsoil and other materials needed for sustaining plant growth, and selecting, installing and establishing appropriate plant species.

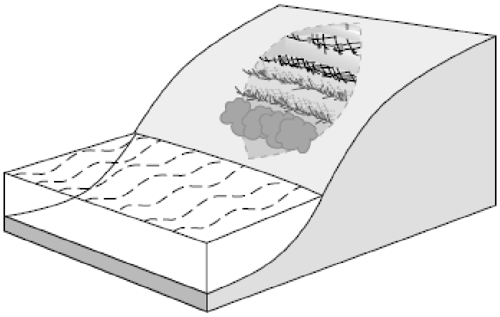
Applications and Effectiveness

- Most successful on streambanks where moderate erosion and channel migration are anticipated.
- Reinforcement at the toe of the embankment is often needed.
- Enhances conditions for colonization of native species.
- Used in conjunction with other protective practices where flow velocities exceed the tolerance range for available plants, and where erosion occurs below base flows.
- Streambank soil materials, probable groundwater fluctuation, and bank loading conditions are factors for determining appropriate slope conditions.
- Slope stability analyses are recommended.

For More Information

- Consult the following references: Nos. 11, 14, 56, 61, 65, 67, 68, 77, 79.

Branch Packing



Alternate layers of live branches and compacted backfill which stabilize and revegetate slumps and holes in streambanks.

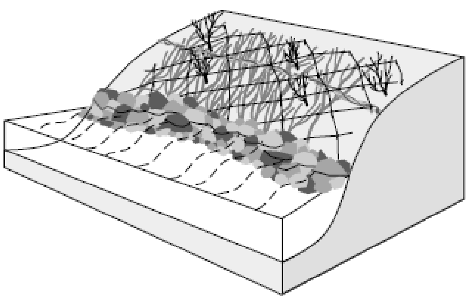
Applications and Effectiveness

- Commonly used where patches of streambank have been scoured out or have slumped leaving a void.
- Appropriate after stresses causing the slump have been removed.
- Less commonly used on eroded slopes where excavation is required to install the branches.
- Produces a filter barrier that prevents erosion and scouring from streambank or overbank flows.
- Rapidly establishes a vegetated streambank.
- Enhances conditions for colonization of native species.
- Provides immediate soil reinforcement.
- Live branches serve as tensile inclusions for reinforcement once installed.
- Typically not effective in slump areas greater than four feet deep or four feet wide.

For More Information

- Consult the following references: Nos. 14, 21, 34, 79, 81.

Brush Mattresses



Combination of live stakes, live facines, and branch cuttings installed to cover and physically protect streambanks; eventually to sprout and establish numerous individual plants.

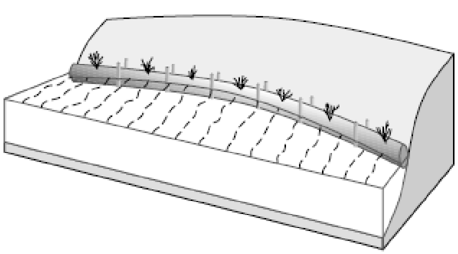
Applications and Effectiveness

- Form an immediate protective cover over the streambank.
- Capture sediment during flood flows.
- Provide opportunities for rooting of the cuttings over the streambank.
- Rapidly restores riparian vegetation and streamside habitat.
- Enhance conditions for colonization of native vegetation.
- Limited to the slope above base flow levels.
- Toe protection is required where toe scour is anticipated.
- Appropriate where exposed streambanks are threatened by high flows prior to vegetation establishment.
- Should not be used on slopes which are experiencing mass movement or other slope instability.

For More Information

- Consult the following references: Nos. 14, 21, 34, 56, 65, 77, 79, 81.

Coconut Fiber Roll



Cylindrical structures composed of coconut husk fibers bound together with twine woven from coconut material to protect slopes from erosion while trapping sediment which encourages plant growth within the fiber roll.

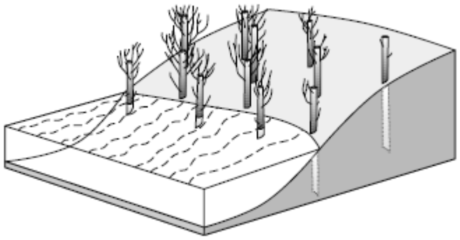
Applications and Effectiveness

- Most commonly available in 12 inch diameter by 20 foot lengths.
- Typically staked near the toe of the streambank with dormant cuttings and rooted plants inserted into slits cut into the rolls.
- Appropriate where moderate toe stabilization is required in conjunction with restoration of the streambank and the sensitivity of the site allows for only minor disturbance.
- Provide an excellent medium for promoting plant growth at the water's edge.
- Not appropriate for sites with high velocity flows or large ice build up.
- Flexibility for molding to the existing curvature of the streambank.
- Requires little site disturbance.
- The rolls are buoyant and require secure anchoring.
- Can be expensive.
- An effective life of 6 to 10 years.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streamside vegetation.
- Enhances conditions for colonization of native vegetation.

For More Information

- Consult the following references: Nos. 65, 77.

Dormant Post Plantings



Plantings of cottonwood, willow, poplar, or other species embedded vertically into streambanks to increase channel roughness, reduce flow velocities near the slope face, and trap sediment.

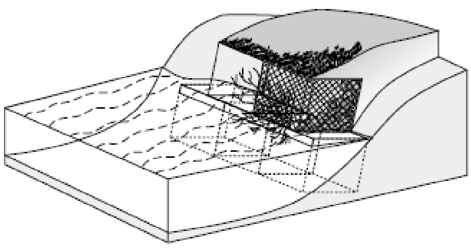
Applications and Effectiveness

- Can be used as live piling to stabilize rotational failures on streambanks where minor bank sloughing is occurring.
- Useful for quickly establishing riparian vegetation, especially in arid regions where water tables are deep.
- Will reduce near bank stream velocities and cause sediment deposition in treated areas.
- Reduce streambank erosion by decreasing the near-bank flow velocities.
- Generally self-repairing and will restem if attacked by beaver or livestock; however, provisions should be made to exclude such herbivores where possible.
- Best suited to non-gravely streams where ice damage is not a problem.
- Will enhance conditions for colonization of native species.
- Are less likely to be removed by erosion than live stakes or smaller cuttings.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streamside vegetation.
- Unlike smaller cuttings, post harvesting can be very destructive to the donor stand, therefore, they should be gathered as 'salvage' from sites designated for clearing, or thinned from dense stands.

For More Information

- Consult the following references: Nos. 65, 77, 79.

Vegetated Gabions



Wire-mesh, rectangular baskets filled with small to medium size rock and soil and laced together to form a structural toe or sidewall. Live branch cuttings are placed on each consecutive layer between the rock filled baskets to take root, consolidate the structure, and bind it to the slope.

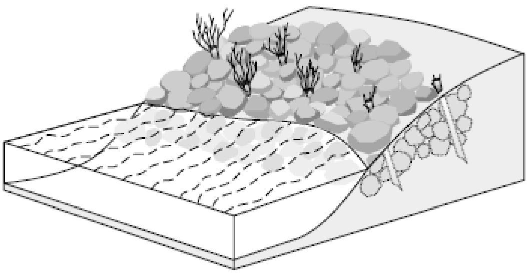
Applications and Effectiveness

- Useful for protecting steep slopes where scouring or undercutting is occurring or there are heavy loading conditions.
- Can be a cost effective solution where some form of structural solution is needed and other materials are not readily available or must be brought in from distant sources.
- Useful when design requires rock size greater than what is locally available.
- Effective where bank slope is steep and requires moderate structural support.
- Appropriate at the base of a slope where a low toe wall is needed to stabilize the slope and reduce slope steepness.
- Will not resist large, lateral earth stresses.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Require a stable foundation.
- Are expensive to install and replace.
- Appropriate where channel side slopes must be steeper than appropriate for riprap or other material, or where channel toe protection is needed, but rock riprap of the desired size is not readily available.
- Are available in vinyl coated wire as well as galvanized steel to improve durability.
- Not appropriate in heavy bedload streams or those with severe ice action because of serious abrasion damage potential.

For More Information

- Consult the following references: Nos. 11, 18, 34, 56, 77.

Joint Plantings



Live stakes tamped into joints or openings between rock which have previously been installed on a slope or while rock is being placed on the slope face.

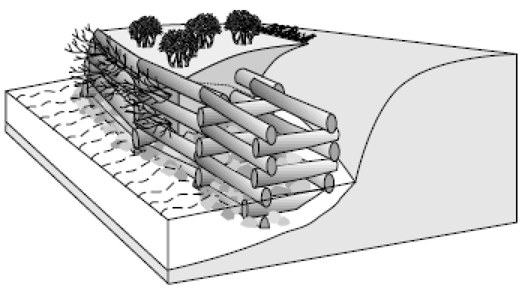
Applications and Effectiveness

- Appropriate where there is a lack of desired vegetative cover on the face of existing or required rock riprap.
- Root systems provide a mat upon which the rock riprap rests and prevents loss of fines from the underlying soil base.
- Root systems also improve drainage in the soil base.
- Will quickly establish riparian vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Have few limitations and can be installed from base flow levels to top of slope, if live stakes are installed to reach ground water.
- Survival rates can be low due to damage to the cambium or lack of soil/ stake interface.
- Thick rock riprap layers may require special tools for establishing pilot holes.

For More Information

- Consult the following references: Nos. 21, 34, 65, 77, 81.

Live Cribwalls



Hollow, box-like interlocking arrangements of untreated log or timber members filled above baseflow with alternate layers of soil material and live branch cuttings that root and gradually take over the structural functions of the wood members.

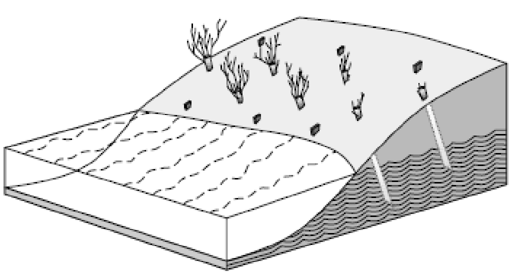
Applications and Effectiveness

- Provide protection to the streambank in areas with near vertical banks where bank sloping options are limited.
- Afford a natural appearance, immediate protection and accelerate the establishment of woody species.
- Effective on outside of bends of streams where high velocities are present.
- Appropriate at the base of a slope where a low wall might be required to stabilize the toe and reduce slope steepness.
- Appropriate above and below water level where stable streambeds exist.
- Don't adjust to toe scour.
- Can be complex and expensive.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.

For More Information

- Consult the following references: Nos. 11, 14, 21, 34, 56, 65, 77, 81.

Live Stakes



Live, woody cuttings which are tamped into the soil to root, grow and create a living root mat that stabilizes the soil by reinforcing and binding soil particles together, and by extracting excess soil moisture.

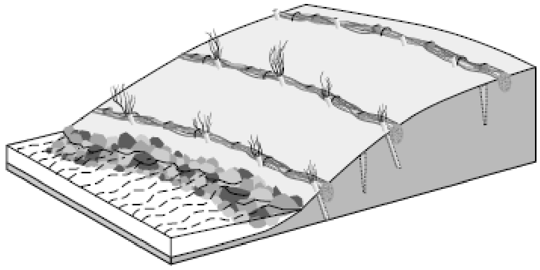
Applications and Effectiveness

- Effective where site conditions are uncomplicated, construction time is limited, and an inexpensive method is needed.
- Appropriate for repair of small earth slips and slumps that are frequently wet.
- Can be used to stake down surface erosion control materials.
- Stabilize intervening areas between other soil bioengineering techniques.
- Rapidly restores riparian vegetation and streamside habitat.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings.
- Enhance conditions for colonization of vegetation from the surrounding plant community.
- Requires toe protection where toe scour is anticipated.

For More Information

- Consult the following references: Nos. 14, 21, 34, 56, 65, 67, 77, 79, 81.

Live Fascines



Dormant branch cuttings bound together into long sausage-like, cylindrical bundles and placed in shallow trenches on slopes to reduce erosion and shallow sliding.

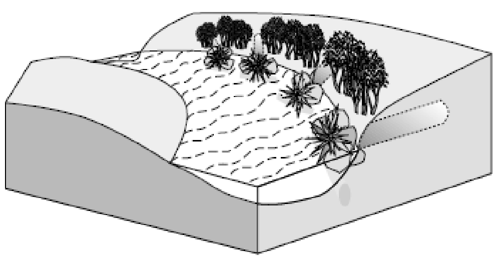
Applications and Effectiveness

- Can trap and hold soil on streambank by creating small dam-like structures and reducing the slope length into a series of shorter slopes.
- Facilitate drainage when installed at an angle on the slope.
- Enhance conditions for colonization of native vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings.
- Requires toe protection where toe scour is anticipated.
- Effective stabilization technique for streambanks, requiring a minimum amount of site disturbance.
- Not appropriate for treatment of slopes undergoing mass movement.

For More Information

- Consult the following references: Nos. 14, 21, 34, 65, 77, 81.

Log, Rootwad, and Boulder Revetments



Boulders and logs with root masses attached placed in and on streambanks to provide streambank erosion, trap sediment, and improve habitat diversity.

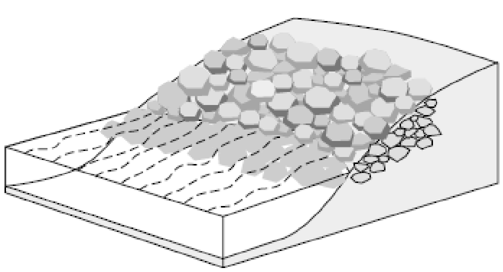
Applications and Effectiveness

- Will tolerate high boundary shear stress if logs and rootwads are well anchored.
- Suited to streams where fish habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Will enhance diversity in riparian areas when used with soil bioengineering systems.
- Will have limited life depending on climate and tree species used. Some species, such as cottonwood or willow, often sprout and accelerate colonization.
- Might need eventual replacement if colonization does not take place or soil bioengineering systems are not used.
- Use of native materials can sequester sediment and woody debris, restore streambanks in high velocity streams, and improve fish rearing and spawning habitat.
- Site must be accessible to heavy equipment.
- Materials might not be readily available at some locations.
- Can create local scour and erosion.
- Can be expensive.

For More Information

- Consult the following references: Nos. 11, 34, 77.

Riprap



A blanket of appropriately sized stones extending from the toe of slope to a height needed for long term durability.

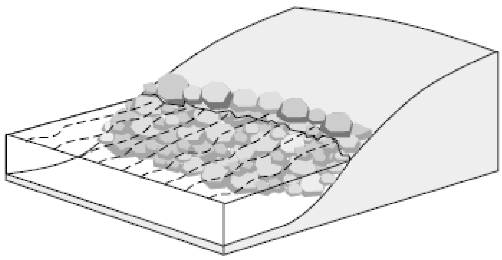
Applications and Effectiveness

- Can be vegetated (see joint plantings).
- Appropriate where long term durability is needed, design discharge are high, there is a significant threat to life or high value property, or there is no practical way to otherwise incorporate vegetation into the design.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Flexible and not impaired by slight movement from settlement or other adjustments.
- Should not be placed to an elevation above which vegetative or soil bioengineering systems are an appropriate alternative.
- Commonly used form of bank protection.
- Can be expensive if materials are not locally available.

For More Information

- Consult the following references: Nos. 11, 14, 18, 34, 39, 56, 67, 70, 77.

Stone Toe Protection



A ridge of quarried rock or stream cobble placed at the toe of the streambank as an armor to deflect flow from the bank, stabilize the slope and promote sediment deposition.

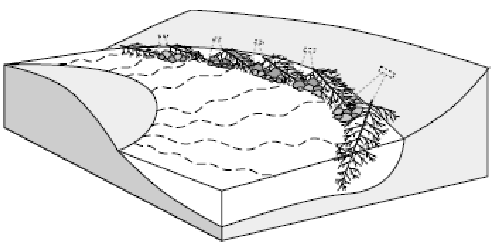
Applications and Effectiveness

- Should be used on streams where banks are being undermined by toe scour, and where vegetation cannot be used.
- Stone prevents removal of the failed streambank material that collects at the toe, allows revegetation and stabilizes the streambank.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerated source of streamside vegetation.
- Can be placed with minimal disturbance to existing slope, habitat, and vegetation.

For More Information

- Consult the following references: Nos. 10, 21, 56, 67, 77, 81.

Tree Revetments



A row of interconnected trees attached to the toe of the streambank or to deadmen in the streambank to reduce flow velocities along eroding streambanks, trap sediment, and provide a substrate for plant establishment and erosion control.

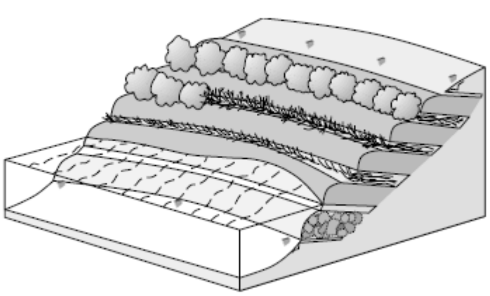
Applications and Effectiveness

- Design of adequate anchoring systems is necessary.
- Wire anchoring systems can present safety hazards.
- Work best on streams with streambank heights under 12 feet and bankfull velocities under 6 feet per second.
- Use inexpensive, readily available materials.
- Capture sediment and enhances conditions for colonization of native species particularly on streams with high bed material loads.
- Limited life and must be replaced periodically.
- Might be severely damaged by ice flows.
- Not appropriate for installation directly upstream of bridges and other channel constrictions because of the potential for downstream damages should the revetment dislodge.
- Should not be used if they occupy more than 15 percent of the channel's cross sectional area at bankfull level.
- Not recommended if debris jams on downstream bridges might cause subsequent problems.
- Species that are resistant to decay are best because they extend the establishment period for planted or volunteer species that succeed them.
- Requires toe protection where toe scour is anticipated.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerated source of streamside vegetation.

For More Information

- Consult the following references: Nos. 11, 21, 34, 56, 60, 77, 79.

Vegetated Geogrids



Alternating layers of live branch cuttings and compacted soil with natural or synthetic geotextile materials wrapped around each soil lift to rebuild and vegetate eroded streambanks.

Applications and Effectiveness

- Quickly establish riparian vegetation if properly designed and installed.
- Can be installed on a steeper and higher slope and has a higher initial tolerance of flow velocity than brush layering.
- Can be complex and expensive.
- Produce a newly constructed, well-reinforced streambank.
- Useful in restoring outside bends where erosion is a problem.
- Capture sediment and enhances conditions for colonization of native species.
- Slope stability analyses are recommended.
- Can be expensive.
- Require a stable foundation.

For More Information

- Consult the following references: Nos. 10, 11, 14, 21, 34, 56, 65, 77.