Montana Department of
Environmental Quality

Kootenai – Fisher Project Area Metals, Nutrients, Sediment, and Temperature TMDLs and Water Quality Improvement Plan

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ACRONYM LIST

Acronym	Definition
AAL	Acute Aquatic Life
AFDM	Ash-Free Dry Mass
AFDW	Ash Free Dry Weight
AL	Aquatic Life
AMB	Abandoned Mine Bureau
AML	Abandoned Mine Lands
ARM	Administrative Rules of Montana
BEHI	Bank Erosion Hazard Index
BFW	Bankfull Width
BLM	Bureau of Land Management (Federal)
BMP	Best Management Practices
CAL	Chronic Aquatic Life
CALA	Controlled Allocation of Liability Act
CECRA	[Montana] Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COOP	Cooperative Observer Program
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DNRC	Department of Natural Resources & Conservation (Montana)
DOI	Department of the Interior (federal)
DOT	Department of Transportation (Montana)
DQO	Data Quality Objectives
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentives Program
FWP	Fish, Wildlife & Parks (Montana)
GIS	Geographic Information System
HBI	Hilsenhoff Biotic Index
HDPE	High-Density Polyethylene
HUC	Hydrologic Unit Code
INFISH	Inland Native Fish Strategy
IR	Integrated Report
KNF	Kootenai National Forest
LA	Load Allocation
LWD	Large Woody Debris
MARS	Montana Aquatic Resources Services, Inc.
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MFISH	Montana Fisheries Information System
MOS	Margin of Safety

Acronym	Definition
MPDES	Montana Pollutant Discharge Elimination System
NEPA	National Environmental Protection Act
NHCP	Native Fish Habitat Conservation Plan
NHD	National Hydrography Dataset
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PEL	Probable Effects Levels
PIBO	PACFISH/INFISH Biological Opinion
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAWS	Remote automatic weather stations
RIT/RDG	Resource Indemnity Trust / Reclamation and Development Grants Program (RIT/RDG)
SAP	Sampling and Analysis Plan
SMCRA	Surface Mining Control & Reclamation Act
SMZ	Streamside Management Zone
SNOTEL	Snowpack Telemetry
STORET	EPA STOrage and RETrieval database
SWPPP	Storm Water Pollution Prevention Plan
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TR	Total Recoverable
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	US Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
UUILT	Ultimate Upper Incipient Lethal Temperature
WEPP	Water Erosion Prediction Project
WLA	Wasteload Allocation
WRP	Watershed Restoration Plan

DOCUMENT SUMMARY

This document presents a total maximum daily load (TMDL) and framework water quality improvement plan for seven impaired streams in the Kootenai-Fisher TMDL Project Area: Big Cherry Creek, Lake Creek, Libby Creek, Raven Creek, Snowshoe Creek, Stanley Creek, and Wolf Creek (**Figure A-8** in **Appendix A**). The 20 TMDLs in this document address impairment from sediment, nutrients, temperature, and metals (**Table DS-1**).

The Montana Department of Environmental Quality (DEQ) develops TMDLs and submits them to the U.S. Environmental Protection Agency (EPA) for approval. The Montana Water Quality Act requires DEQ to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. TMDLs provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses. In general, improvements in management practices are recommended to help improve water quality and meet water quality standards.

The project area encompasses approximately 2,503 square miles and contains the Fisher River watershed and a portion of the Kootenai River watershed, located in northwestern Montana (**Figure A-1** in **Appendix A**). The majority of the project area is contained in Lincoln County but a very small portion lies in Flathead County. The Salish and Cabinet Mountains create drainage divides to the east and south and the Yaak River drainage lies to the northwest. Bobtail Creek is within the project area but was excluded from this project because TMDLs were completed there in 2005 (Lindgren and Anderson, 2005). It is also important to note that the Kootenai River itself is not included in this TMDL project and will be addressed during future TMDL development efforts.

Sediment

Four sediment TMDLs are provided for four waterbody segments in the Kootenai-Fisher TMDL Project Area (**Table DS-1**): Lake, Libby, Raven, and Wolf creeks. Bristow and Quartz creeks are on the 2012 303(d) List for sediment impairment, but data collected to support TMDL development indicate they are no longer impaired for sediment and will be removed from the 303(d) list. For the four streams with sediment TMDLs, excess sediment is limiting their ability to fully support aquatic life. Water quality restoration goals for sediment were established in this document on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available instream habitat as it relates to the effects of sediment, and the stability of streambanks. DEQ believes that once these water quality restoration goals are met, all beneficial uses currently affected by sediment will be restored.

Existing sediment loads are quantified for the following sources: streambank erosion, hillslope erosion, unpaved roads, and permitted point sources. To meet the TMDLs, permit conditions must be followed for point sources and nonpoint sources must implement all reasonable land, soil, and water conservation practices. Annual reductions in sediment loading of 12% to 29% are necessary to meet the TMDLs and satisfy the water quality restoration goals. Recommended strategies for achieving the sediment reduction goals are also presented in this plan. They include best management practices (BMPs) for maintaining unpaved roads and improving upland land cover and expanding riparian buffer areas by using land, soil, and water conservation practices that improve stream channel conditions and associated riparian vegetation.

Nutrients

Three nutrient TMDLs are provided for three waterbody segments in the Kootenai-Fisher TMDL Project Area (**Table DS-1**): Nitrate/nitrite for Lake and Stanley creeks and total phosphorus for Raven Creek. Nutrient and/or biological data in these streams indicate nutrients are present in concentrations that can cause algal growth that harms recreation and aquatic life beneficial uses. Water quality restoration goals for nutrients were based on Montana's draft numeric nutrient criteria, measures of algal growth/density, and biological metrics for macroinvertebrates and periphyton.

Potential sources are mining (from blasting residuals), timber harvest, septic systems, and grazing. Based on monitoring data, mining is a dominant source of nitrate/nitrite loading to Stanley and Lake Creeks, but other sources are contributing as well. For Raven Creek, excess sediment associated with unpaved roads, streambank erosion, and upland sources is the primary source of phosphorus. For Stanley and Lake creeks, additional monitoring and refinement of the source assessment is recommended to help determine where and which type of BMPs will be most effective. For Raven Creek, BMPs necessary to meet the sediment TMDL are anticipated to result in meeting the total phosphorus TMDL. TMDL examples based on monitoring data indicate reductions up to 86% are necessary. However for all three streams, exceedances of the water quality standard are very sporadic, indicating only minor improvements are necessary to meet the TMDLs.

Temperature

A temperature TMDL was completed for Wolf Creek. Historic removal of riparian vegetation, which is important for regulating stream temperature by providing shade, is the primary cause of impairment. Water quality restoration goals focus on improving riparian shade, however, maintaining stable stream channel morphology and instream flow conditions during the hottest months of the summer are also important for meeting the TMDL. DEQ believes that once these water quality goals are met, all water uses currently affected by temperature will be restored given all reasonable land, soil, and water conservation practices.

The Wolf Creek temperature TMDL indicates that reductions in maximum daily water temperatures ranging from 0.7°F to 7.8°F are necessary. General strategies for achieving the instream water temperature reduction goals are also presented in this plan and include BMPs for managing riparian areas.

Metals

Twelve metals TMDLs are provided for four waterbody segments in the Kootenai Fisher TMDL Project Area (**Table DS-1**): Big Cherry, Lake, Snowshoe, and Stanley Creeks. The metals of concern include: arsenic, cadmium, copper, lead, and zinc. Water quality restoration goals for metals are established based on numeric water quality criteria defined in Montana's Numeric Water Quality Standards. DEQ believes that once these water quality goals are met, all water uses currently affected by metals will be restored.

Metals loads are quantified for natural background conditions, abandoned mines, and diffuse sources (e.g., land management practices that increase erosion of mineralized soils). The metals TMDLs require reductions in metals loads ranging from 0% to 98%, which mostly rely on reclamation of abandoned mines. State and federal programs, as well as potential funding resources, to address metals sources are summarized in this plan.

Water Quality Improvement Measures

Implementation of water quality improvement measures described in this plan is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this TMDL document and associated information as a tool to guide local water quality improvement activities. Such activities can be documented within a watershed restoration plan consistent with DEQ and EPA recommendations.

A flexible approach to most nonpoint source TMDL implementation activities may be necessary as more knowledge is gained through implementation and future monitoring. The plan includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals, and to help refine the plan during its implementation.

Although most water quality improvement measures are based on voluntary measures, federal law specifies permit requirements developed to protect narrative water quality criterion, a numeric water quality criterion, or both, to be consistent with the assumptions and requirements of wasteload allocations (WLAs) on streams where TMDLs have been developed and approved by EPA. The sediment TMDL for the lower segment of Libby Creek includes wasteload allocations for two permitted discharges.

Table DS-1. List of Impaired Waterbodies and Their Impaired Uses in the Kootenai-Fisher TMDL Project Area with Completed Metals, Nutrients, Sediment, and Temperature TMDLs Contained in this Document

Waterbody & Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Use(s) [1]
BIG CHERRY CREEK, Snowshoe Creek to mouth (Libby Creek)	Cadmium	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
	Zinc	Metals	Aquatic Life
LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
	Nitrate + Nitrite	Nutrients	Aquatic Life Primary Contact Recreation
	Sediment / Siltation	Sediment	Aquatic life
LIBBY CREEK, Highway 2 bridge to mouth (Kootenai River)	Sediment / Siltation	Sediment	Aquatic life
RAVEN CREEK, Headwaters to mouth (Pleasant Valley Fisher River)	Total Phosphorus	Nutrients	Aquatic life Primary Contact Recreation
	Sediment / Siltation	Sediment	Aquatic Life
SNOWSHOE CREEK, Cabinet Wilderness boundary to mouth (Big Cherry Creek)	Arsenic	Metals	Drinking Water
	Cadmium	Metals	Aquatic Life Drinking Water
	Lead	Metals	Aquatic Life Drinking Water
	Zinc	Metals	Aquatic Life

Table DS-1. List of Impaired Waterbodies and Their Impaired Uses in the Kootenai-Fisher TMDL Project Area with Completed Metals, Nutrients, Sediment, and Temperature TMDLs Contained in this Document

Waterbody & Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Use(s) [1]
STANLEY CREEK,[2] Headwaters to mouth (Lake Creek)	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
	Zinc	Metals	Aquatic Life
	Nitrate + Nitrite	Nutrients	Aquatic life Primary Contact Recreation
WOLF CREEK, Headwaters to mouth (Fisher River)	Sediment / Siltation	Sediment	Aquatic Life
	Temperature	Temperature	Aquatic Life

[1] Impaired uses given in this table are based on updated assessment results and may not match the "2012 Water Quality Integrated Report."

[2] The Stanley Creek waterbody segment location description reads as "Stanley Creek, headwaters to confluence with Fairway Creek" in the 2012 Integrated Report. The segment was extended to the confluence with Lake Creek and the new location description will be reflected in the 2014 Integrated Report

1.0 PROJECT OVERVIEW

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for metals, nutrients, sediment, and temperature problems in the Kootenai – Fisher TMDL Project Area. This document also presents a general framework for resolving these problems. **Figure A-1** found in **Appendix A** shows the location of the project area and **Figure A-8** shows the waterbodies in the Kootenai – Fisher TMDL Project Area with metals, nutrients, sediment, and temperature pollutant impairments. This project addresses streams from both the Kootenai TMDL Planning Area and the Fisher TMDL Planning area, and is thus called the Kootenai – Fisher TMDL Project Area.

1.1 WHY WE WRITE TMDLS

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). The CWA's goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires each state to designate uses of their waters and to develop water quality standards to protect those uses.

Montana's water quality designated use classification system includes the following:

- fish and aquatic life
- wildlife
- recreation
- agriculture
- industry
- drinking water

Each waterbody in Montana has a set of designated uses from the list above. Montana has established water quality standards to protect these uses, and a waterbody that does not meet one or more standards is called an impaired water. Each state must monitor their waters to track if they are supporting their designated uses, and every two years the Montana Department of Environmental Quality (DEQ) prepares a Water Quality Integrated Report (IR) which lists all impaired waterbodies and their identified impairment causes. Impairment causes fall within two main categories: pollutant and non-pollutant.

Montana's biennial IR identifies all the state's impaired waterbody segments. The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL, whereas TMDLs are not required for non-pollutant causes of impairments. **Table A-1** in **Appendix A** identifies all impaired waters for the Kootenai-Fisher TMDL Project Area from Montana's 2012 303(d) List, and includes non-pollutant impairment causes included in Montana's "2012 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012a). **Table A-1** provides the current status of each impairment cause, identifying whether it has been addressed by TMDL development.

Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal CWA require the development of total maximum daily loads for all impaired waterbodies when water quality is impaired by a pollutant. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Developing TMDLs and water quality improvement strategies includes the following components, which are further defined in **Section 4.0**:

- Determining measurable target values to help evaluate the waterbody's condition in relation to the applicable water quality standards
- Quantifying the magnitude of pollutant contribution from their sources
- Determining the TMDL for each pollutant based on the allowable loading limits for each waterbody-pollutant combination
- Allocating the total allowable load (TMDL) into individual loads for each source

In Montana, restoration strategies and monitoring recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation (see **Sections 10.0** and **11.0** of this document).

Basically, developing a TMDL for an impaired waterbody is a problem-solving exercise: The problem is excess pollutant loading that impairs a designated use. The solution is developed by identifying the total acceptable pollutant load (the TMDL), identifying all the significant pollutant-contributing sources, and identifying where pollutant loading reductions should be applied to achieve the acceptable load.

1.2 WATER QUALITY IMPAIRMENTS AND TMDLS ADDRESSED BY THIS DOCUMENT

Table 1-1 below lists all of the impairment causes from the "2012 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012a) that are addressed in this document (also see **Figure A-8** in **Appendix A**). Each pollutant impairment falls within a TMDL pollutant category (e.g., metals, nutrients, sediment, or temperature), and this document is organized by those categories.

New data assessed during this project identified new nutrient and metals impairment causes for seven waterbodies. These impairment causes are identified in **Table 1-1** and noted as not being on the 2012 303(d) List (within the integrated report). Instead, these waters will be documented within DEQ assessment files and incorporated into the 2014 IR.

TMDLs are completed for each waterbody – pollutant combination, and this document contains 20 TMDLs (**Table 1-1**). There are several non-pollutant types of impairment that are also addressed in this document. As noted above, TMDLs are not required for non-pollutants, although in many situations the solution to one or more pollutant problems will be consistent with, or equivalent to, the solution for one or more non-pollutant problems. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 9.0**. **Sections 10.0** and **11.0** also provide some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document.

DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or a couple of specific pollutant types. This document only addresses those impairments identified in **Table 1-1**. This project did not include the Kootenai River or Lake Koocanusa. The Kootenai River is identified on the "2012 Water Quality Integrated Report" as having a temperature impairment and Lake Koocanusa has an identified selenium impairment in the 2012 IR (**Table A-1** in **Appendix A**). DEQ has been conducting water quality monitoring on both waterbodies and both will be addressed in a future project. Additionally, Cripple Horse, Dry, and Keeler creeks have non-pollutant impairments that were not addressed in this project, but are discussed in **Section 9.0**.

In 2005, a sediment TMDL was completed for Bobtail Creek, a tributary to the Kootenai River (**Figure A-1** in **Appendix A**). The "Water Quality Restoration Plan and Total Maximum Daily Loads (TMDL) for the Bobtail Creek Watershed" includes strategies for implementation and monitoring (Lindgren and Anderson, 2005). DEQ will conduct water quality monitoring and complete a TMDL Implementation Evaluation in the future to evaluate water quality conditions and determine if water quality standards are being met and Bobtail Creek's designated uses are being supported.

Table 1-1. Water Quality Impairment Causes for the Kootenai-Fisher TMDL Project Area Addressed within this Document

Waterbody & Location Description [1]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status [2]	Included in 2012 Integrated Report [3]
BIG CHERRY CREEK, Snowshoe Creek to mouth (Libby Creek)	MT76D002_050	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
		Cadmium	Metals	Cadmium TMDL completed	No
		Lead	Metals	Lead TMDL completed	No
		Zinc	Metals	Zinc TMDL completed	Yes
BRISTOW CREEK, headwaters to mouth at Lake Koocanusa	MT76D002_110	Nitrogen (Total)	Nutrients	Not impaired based on updated assessment	Yes
		Sedimentation / Siltation	Sediment	Not impaired based on updated assessment	Yes
CRIPPLE HORSE CREEK, Headwaters to mouth (Lake Koocanusa)	MT76D002_100	Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
DRY CREEK, 1 mile upstream from State Highway 56 to mouth (Lake Creek)	MT76D002_020	Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
FISHER RIVER, Silver Butte / Pleasant Valley junction to mouth (Kootenai River)	MT76C001_010	Lead	Metals	Not impaired based on updated assessment	Yes
KEELER CREEK, Headwaters to Lake Creek	MT76D002_030	Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes

Table 1-1. Water Quality Impairment Causes for the Kootenai-Fisher TMDL Project Area Addressed within this Document

Waterbody & Location Description [1]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status [2]	Included in 2012 Integrated Report [3]
LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)	MT76D002_070	Cadmium	Metals	Not impaired based on updated assessment	Yes
		Copper	Metals	Copper TMDL completed	Yes
		Lead	Metals	Lead TMDL completed	Yes
		Mercury in water column	Metals	Not impaired based on updated assessment	Yes
		Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	NO_2 + NO_3 TMDL completed	Yes
		Sedimentation / Siltation	Sediment	Sediment TMDL completed	Yes
		Zinc	Metals	Not impaired based on updated assessment	Yes
LIBBY CREEK, from 1 mile above Howard Creek to Highway 2 bridge	MT76D002_061	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
		Mercury	Metals	Not impaired based on updated assessment	Yes
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
LIBBY CREEK, Highway 2 bridge to mouth (Kootenai River)	MT76D002_062	Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed by sediment TMDL	Yes
		Sedimentation / Siltation	Sediment	Sediment TMDL completed	Yes
QUARTZ CREEK, Headwaters to confluence with Kootenai River	MT76D002_090	Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Not impaired based on updated	Yes
		Sedimentation / Siltation	Sediment	Not impaired based on updated assessment	Yes

Table 1-1. Water Quality Impairment Causes for the Kootenai-Fisher TMDL Project Area Addressed within this Document

Waterbody & Location Description [1]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status [2]	Included in 2012 Integrated Report [3]
RAVEN CREEK, Headwaters to mouth (Pleasant Valley Fisher River)	MT76C001_030	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by sediment TMDL	Yes
		Chlorophyll-*a*	Not Applicable; Non-Pollutant	Addressed by TP TMDL	Yes
		Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	Not impaired based on updated assessment	Yes
		Nitrogen (Total)	Nutrients	Not impaired based on updated assessment	Yes
		Phosphorus (Total)	Nutrients	TP TMDL completed	Yes
		Sedimentation / Siltation	Sediment	Sediment TMDL completed	Yes
SNOWSHOE CREEK, Cabinet Wilderness boundary to mouth (Big Cherry Creek)	MT76D002_040	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed within document (**Sections 9** and **10**); not linked to a TMDL	Yes
		Arsenic	Metals	Arsenic TMDL completed	No
		Cadmium	Metals	Cadmium TMDL completed	Yes
		Lead	Metals	Lead TMDL completed	No
		Zinc	Metals	Zinc TMDL completed	Yes
STANLEY CREEK, Headwaters to mouth (Lake Creek) [4]	MT76D002_010	Copper	Metals	Copper TMDL completed	Yes
		Lead	Metals	Lead TMDL completed	No
		Zinc	Metals	Zinc TMDL completed	No
		Nutrient / Eutrophication Biological Indicators	Nutrients	Impairment cause removed; replaced by $NO_2 + NO_3$	Yes
		Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	$NO_2 + NO_3$ TMDL completed	No
WOLF CREEK, Headwaters to mouth (Fisher River)	MT76C001_020	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by sediment TMDL	Yes
		Sedimentation / Siltation	Sediment	Sediment TMDL completed	Yes
		Temperature, water	Temperature	Temperature TMDL completed	Yes

[1] All waterbody segments within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset (NHD)

[2] TP = Total Phosphorus, NO_2+NO_3 = Nitrite + Nitrate

[3] Impairment causes not in the "2012 Water Quality Integrated Report" were recently identified and will be included in the 2014 Integrated Report.

[4] The Stanley Creek waterbody segment location description reads as "Stanley Creek, headwaters to confluence with Fairway Creek" in the 2012 Integrated Report. The segment was extended to the confluence with Lake Creek and the new description will be reflected in the 2014 Integrated Report.

1.3 WHAT THIS DOCUMENT CONTAINS

This document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy, as well as a strategy to address impairment causes other than metals, nutrients, sediment, and temperature. The TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices and attachments. In addition to this introductory section, this document includes:

Section 2.0 Kootenai-Fisher Project Area Description:
Describes the physical characteristics and social profile of the project area.

Section 3.0 Montana Water Quality Standards
Discusses the water quality standards that apply to the Kootenai-Fisher project area.

Section 4.0 Defining TMDLs and Their Components
Defines the components of TMDLs and how each is developed.

Sections 5.0 – 8.0 Sediment, Temperature, Nutrients, and Metals TMDL Components (sequentially):
Each section includes (a) a discussion of the affected waterbodies and the pollutant's effect on designated beneficial uses, (b) the information sources and assessment methods used to evaluate stream health and pollutant source contributions, (c) water quality targets and existing water quality conditions, (d) the quantified pollutant loading from the identified sources, (e) the determined TMDL for each waterbody, (f) the allocations of the allowable pollutant load to the identified sources.

Section 9.0 Non-Pollutant Impairments:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in the plan might address some of these concerns. This section also provides recommendations for combating these problems.

Section 10.0 Water Quality Improvement Plan:
Discusses water quality restoration objectives and a strategy to meet the identified objectives and TMDLs.

Section 11.0 Monitoring Strategy and Adaptive Management:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of the "Kootenai-Fisher Project Area Metals, Nutrients, Sediment, and Temperature TMDLs and Water Quality Improvement Plan."

Section 12.0 Public Participation & Public Comments:
Describes other agencies and stakeholder groups who were involved with the development of this plan and the public participation process used to review the draft document. Addresses comments received during the public review period.

2.0 KOOTENAI – FISHER PROJECT AREA DESCRIPTION

This section includes a summary of the physical, ecological and cultural profile of the Kootenai-Fisher Project Area and is intended to provide background information to support total maximum daily load (TMDL) development. The maps referenced in this discussion are contained in **Appendix A, Table of Waterbody Impairments and Project Area Description Maps**.

2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Kootenai-Fisher TMDL Project Area and includes a discussion of location, topography, geology, soils, surface water, groundwater and climate.

2.1.1 Location

The project area encompasses approximately 2,503 square miles in northwestern Montana as shown in **Figure A-1**. The project area encompasses the Fisher River watershed and a portion of the Kootenai River watershed. Majority of the project area is contained in Lincoln County and includes the Town of Troy and the City of Libby. A very small portion of the project area lies in Flathead County. The project area is bounded to the north by Canada and to the west by the Idaho state line. The Salish and Cabinet Mountains create drainage divides to the east and south and the Yaak River drainage lies to the northwest. The omitted land inside the project area’s perimeter is the Bobtail Creek watershed which is not included in the Kootenai-Fisher Project Area because it was the subject of previous TMDL work, resulting in the 2005 ”Water Quality Restoration Plan and Total Maximum Daily Loads (TMDL) for the Bobtail Creek Watershed” document (Lindgren and Anderson, 2005). It is also important to note that the Kootenai River itself is not included in this TMDL project, and therefore this project area description does not include a profile of the river or Lake Koocanusa.

2.1.2 Topography

Elevations in the Kootenai-Fisher Project Area range from approximately 1,800 feet above sea level where the Kootenai River flows out of the project area into Idaho, to approximately 8,700 feet on the summit of A Peak in the Cabinet Mountains. Valley bottom elevations average around 2,600 feet. The landscape is dominated by mountain ranges intercepted by large river valleys. Elevation is mapped on **Appendix A**, **Figure A-2**. Like topography, slopes in the project area vary greatly. The flat valley bottoms register 0° slopes but the steepest parts of the Cabinet Mountains have slopes over 80°. **Appendix A, Figure A-3** shows slopes calculated from the 30-meter National Elevation Dataset.

2.1.3 Geology

Appendix A, Figure A-4 and **Figure A-5** provide an overview of the generalized geology based on a 1:500,000 scale geologic map of the state (Raines and Johnson, 1995). The first map displays standard geologic units and the second map indicates the dominant type of rock found in each unit.

Bedrock

Metasedimentary rocks from the Precambrian Eon formed 1,600 – 1,000 million years ago are the oldest and most widespread basement rocks in the project area. The primary rock types comprising this Belt Supergroup series are meta-argillite, quartzite and carbonate. The first two listed are formed under intense heat and pressure making them reasonably resistant to erosion. Later in the Cretaceous Era (100

– 65 million years ago) the Belt Series was punctuate by igneous intrusions in small portions of the project area and extensive mountain building occurred. These intrusions are associated with the Idaho Batholith unit and are mostly granitic.

Glaciation

Within the last 3 million years, the Cordilleran ice sheet advanced and retreated numerous times across the project area producing three forms of Quaternary deposits: lake sediments (lacustrine), river sediments (fluvial) and glacially-derived sediment. During the most recent Pinedale glaciation (16,000 years ago), the Kootenai-Fisher project area was the southern-most extent of the Cordilleran ice sheet that stretched as far north as the Alaskan Peninsula and covered everything but the highest Cabinet Mountain peaks (**Figure 2-1**). The maximum thickness of the ice sheet near the confluence of the Fisher River was approximately 4,000 feet (Langer et al., 2011). As the glacier started to thin, more mountains ranges were exposed and northward-retreating glaciers were confined to valleys. The northward-flowing tributaries to the Kootenai River, such as Libby Creek, Lake Creek and the Fisher River, were ice-dammed lakes during this time. Water level in these individual glacial lakes fluctuated as the ice sheet melted and various spillways were created until the Kootenai River valley opened up and the smaller lakes merged into one Glacial Lake Kootenai (Langer et al., 2011). As the ice sheet continued to retreat-northward Glacial Lake Kootenai drained and became a braided river system downcutting through lacustrine deposits creating gravel terraces and point bars. Ice dams in present day Idaho caused portions of Glacial Lake Kootenai to reflood at least once more before draining for a final time around 11,000 years ago. Glacial processes formed cirques, moraines, and U-shaped valleys we recognize today as the landscape in the Kootenai-Fisher project area.

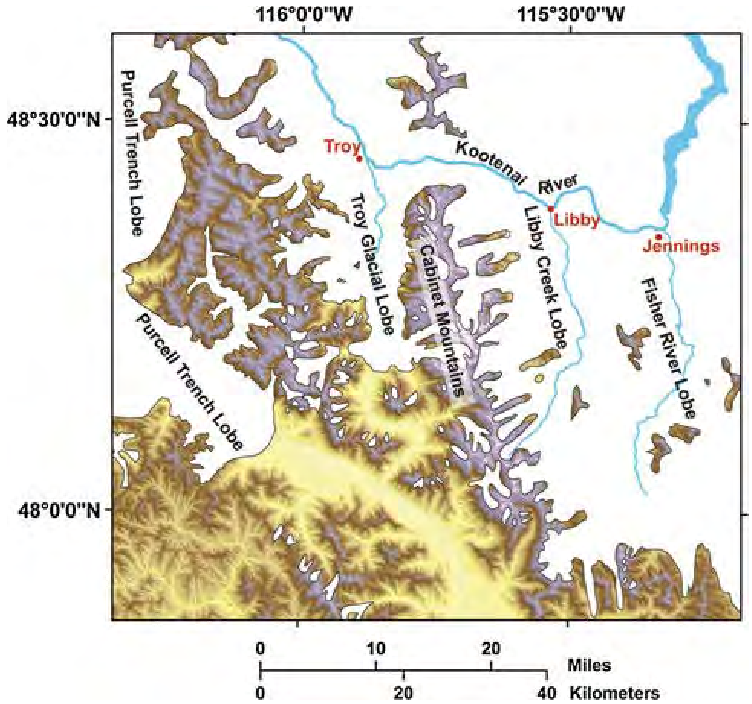

Figure 2-1. Map showing the maximum extent of the Cordilleran ice sheet in the Libby area (Langer et al., 2011)

2.1.4 Soil

The U.S. General Soil Map developed by the National Cooperative Soil Survey and based on the STATSGO2 dataset was used to evaluate soil properties in the Kootenai-Fisher Project Area. **Appendix A**, **Figure A-6** depicts coverage of the five soil orders that exist within the project area. Soil orders are the broadest level of soil taxonomy and combine soils into units with similar physical and chemical attributes. Soils of the same order typically share properties because they formed under similar scenarios. Investigating the distribution of soil orders in the project area can help better understand soil behavior and potential effects to water quality.

Inceptisols are the most common order in the project area and are known for only having a slight degree of weathering and soil development because they are considered geologically young or because the conditions under which they exist have only led to a slight modification from their original state. Inceptisols are found in the mountainous regions along with Andisols which are also considered relatively unweathered. Andisols are uniquely derived from ash and cinders deposited near or downwind of volcanic eruptions. When combined with sufficient organic matter, as is the case in the Kootenai-Fisher Project Area where evergreen forests dominate the landscape and precipitation is relatively high, Andisols have a high water-holding capacity and resist erosion. Valleys and portions of the Salish Mountains are classified under the Alfisol soil order. These soils are moderately weathered and distinguished by an accumulation of silicate clay in the soil profile. Alfisols are susceptible to erosion, especially if the soil is high in sand content and the natural litter layer is disturbed (Brady and Weil, 2002). The remaining soils (< 4% of the project area) are Entisols or Mollisols: Entisols are the least developed soil order; Mollisols are moderately weathered, typically develop under grasslands, and are distinguished by an accumulation of calcium-rich organic matter. The Entisol unit surrounding Lake Creek just south of Troy matches the location of a smaller glacier that became isolated from the Cordilleran ice sheet. As Glacial Lake Libby drained to the west, alluvial sediments were caught between this detached ice sheet and the western valley (Langer et al., 2011) thus explaining the early stage of soil development in that localized area.

A soil’s susceptibility to erosion is a property especially relevant to TMDLs when reviewing upland sources. Erodibility is mapped in **Appendix A**, **Figure A-7** using the K-factor from the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978). The K-factor is an inherent property of the soil that is independent of rainfall, slope, vegetation cover, and management differences. Values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Soil erodibility is assigned to the following ranges: low (0.0-0.2), moderate-low (0.21-0.30) and moderate-high (0.31-0.40). Values of > 0.4 are considered highly susceptible to erosion. The majority of the project area has moderate-high susceptibility soils (41%) or low susceptibility soils (38%). Another 8% is identified as moderate-low susceptibility and less than 1% is high susceptibility. All soil units identified as highly susceptible to erosion are Alfisols, supporting the general properties described previously for that soil order. The remaining area (13%) is either open water or does not have data available to determine K-factors.

2.1.5 Surface Water

This project combines the Fisher River watershed (HUC 1710102) and a portion of the Upper Kootenai River watershed (HUC 17010101) into one TMDL project area. Water originating in the headwaters region of Fisher River joins the Kootenai River flowing out of Lake Koocanusa, which is filled by tributaries on both sides of the international boundary, and continues flowing westward as the Kootenai River until it exits the project area northwest of Troy. The Kootenai and Fisher watersheds are part of the larger Columbia River Basin which eventually discharges into the Pacific Ocean. No stream sections in the project area have been given National Wild and Scenic River status, although many are considered eligible candidates by the USFS (U.S. Forest Service, 2011). **Appendix A**, **Figure A-8** displays impaired waterbodies in the planning area according to the 2012 303(d) List. Some of these impairment determinations have been revised following assessments performed during this TMDL project and those adjustments will be captured on subsequent 303(d) lists. Also note that the Kootenai River and Lake Koocanusa have current impairment listings, but these waterbodies will be addressed separate from the Kootenai-Fisher Project Area TMDLs and therefore are not identified impaired in **Appendix A**, **Figure A-8**.

The United States Geological Survey (USGS) has established numerous gage sites in the project area. **Appendix A, Figure A-8** indicates which sites are actively recording continuous data and which have been retired. One of the active stations monitors the outflow of a wetland below Schrieber Lake. Summary information for the other two active stations is listed in **Table 2-1**.

Table 2-1. Active USGS stream gages

Site Name	Site Number	Period of Record *	Average Peak Flow (cfs)
Kootenai River bl Libby Dam nr Libby MT	12301933	1971-present (42 years)	30,110
Fisher River near Libby MT	12302055	1967-present (46 years)	3,374

* Present = 2012

The average monthly discharge for these two sites over the period of record is displayed in **Figure 2-2**, note the logarithmic scale. Forty-six years of recorded data on the Fisher River indicate flows most often peak during May and reach a minimum in September. This pattern is typical of snowmelt - dominated stream systems in Montana. The Fisher River hydrograph looks much different than the Kootenai River hydrograph due to alterations of the natural flow regime. The USGS gaging station on the Kootenai River is located 0.7 miles downstream of the Libby Dam and 2.8 miles upstream of the Fisher River confluence. Flows have been regulated by dam operations at this site since March 21, 1972.

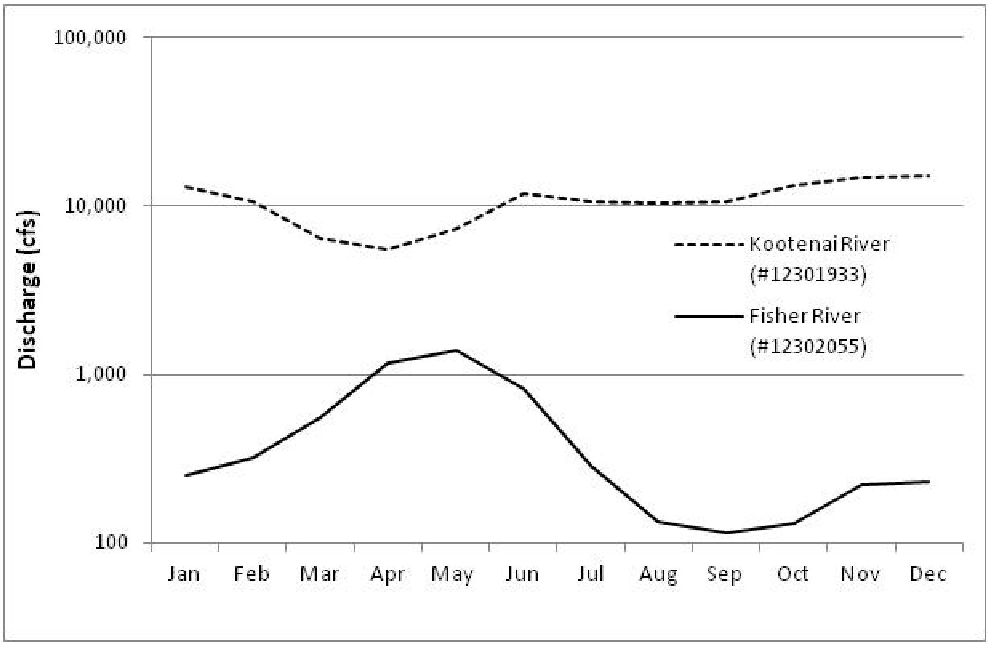

Figure 2-2. Average monthly discharge comparison

2.1.6 Groundwater

There are two main types of aquifers in the Kootenai-Fisher Project Area. The first are commonly found surrounding present day stream channels in alluvial sand and gravel material. These shallow aquifers are often unconfined and hydraulically connected to adjacent surface water. The second class is characteristically similar but derived from glacially deposited till and can be further removed from surface water. **Appendix A, Figure A-9** depicts groundwater wells and distinguishes those with water quality data available online from the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center. As of November 2012 there are approximately 4,300 wells in the Kootenai-Fisher Project Area. Well distribution largely follows population density (**Appendix A, Figure A-14**) with the highest concentrations surrounding the towns of Rexford, Libby, and Troy and stretching south from Troy along the Bull River Highway (MT 56). Most wells in the vicinity of Libby utilize glacial aquifers

2.1.7 Climate

The Kootenai-Fisher Project Area's climate is characterized by long, cool winters and relatively short, temperate summers. This portion of Montana has a much wetter climate than the rest of the state. Moderated temperature extremes and higher annual precipitation prompt many to compare the climate with that of the Pacific Northwest. Slightly more precipitation falls in the Kootenai-Fisher Project Area during the winter months but overall precipitation remains fairly consistent at individual locations. Across the project area, precipitation varies dramatically from 13 inches a year near the town of Rexford up to 100 inches in the Cabinet Mountains. Precipitation trends follow elevation: significant moisture falls in the mountains and the quantity gradually decreases with elevation to the lowest spots of the Kootenai River Valley. Average annual precipitation isolines for the time period 1981-2010 are mapped on **Appendix A, Figure A-10** using data provided by Oregon State University's PRISM Group (PRISM Climate Group, 2013).

At least eleven weather stations have collected continuous climate data in the project area recently, and many are still collecting information. These stations are plotted in **Appendix A, Figure A-10** and symbolized according to the monitoring network they belong to. Remote automatic weather stations, or RAWS, is a multi-agency collaboration that focuses on conditions related to wildland fires. SNOTEL, short for snowpack telemetry, is an automated system of snowpack and related climate sensors used to develop water supply forecasts and operated by the Natural Resource Conservation Service (NRCS). The National Weather Service administers two additional climate systems in the region, the Cooperative Observer Program (COOP) stations, and the Missoula Weather Forecast Office (MSOWFO) stations. Finally, the Montana Department of Transportation (MT DOT) also collects weather data for road condition monitoring on US Highway 2.

In an attempt to show the range of observations, monthly climate averages are presented in **Table 2-2** and **Table 2-3** for stations at different elevations, both located on north-facing slopes. **Table 2-2** summarizes the National Weather Service's COOP site 245000 in Libby, Montana. In Libby, summer high temperatures peak in July and August in the mid-80s and minimum temperatures average 20 degrees in December and January. At 2,140 feet, this site has a warmer and drier climate than that of the Poorman Creek station shown in **Table 2-3.** Poorman Creek is a SNOTEL site located in the Cabinet Mountains at 5,100 feet. In addition to cooler temperatures, Poorman Creek has a much larger snowpack averaging a maximum of over seven and a half feet in March. According to climate records, snowfall has been observed in the project area during every month of the year.

Table 2-2. Monthly climate summary for Libby, MT (1998-2011)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Max Temp (°F)	32.7	38.4	47.4	57.9	68.0	75.3	87.0	84.1	71.4	54.4	39.0	30.6
Avg Min Temp (°F)	21.3	22.8	26.8	31.0	38.4	45.1	49.2	47.4	40.2	31.9	27.1	20.7
Avg Total Precip (in)	1.66	0.93	1.39	0.63	1.49	1.32	0.76	0.69	0.96	1.52	1.90	1.98
Avg Snowfall (in)	9.33	5.56	0.98	0.07	0.00	0.00	0.00	0.00	0.00	0.14	3.92	7.94
Avg Snowdepth (in)	15.77	13.15	10.69	1.00	0.00	0.00	0.00	0.00	0.00	0.15	3.29	11.50

Table 2-3. Monthly climate summary for Poorman Creek (1998-2011)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Max Temp (°F)	30.1	31.9	38.6	45.3	52.2	59.6	71.2	70.3	61.3	46.5	35.0	28.7
Avg Min Temp (°F)	19.7	20.5	25.0	29.5	35.0	40.6	48.2	46.9	40.5	33.3	25.2	18.5
Avg Snowdepth (in)	64.62	83.23	94.65	89.19	52.52	9.66	0.03	0.00	0.07	1.32	14.14	38.72

2.2 ECOLOGICAL PARAMETERS

The flowing information describes the ecological characteristics of the Kootenai-Fisher Project Area and includes a discussion of ecoregions, fires, aquatic life and terrestrial life.

2.2.1 Ecoregion

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources (Woods et al., 2002). The classification incorporates a wide array of subjects including geology, physiography, vegetation, climate, soils, land use, wildlife and hydrology.

Over 99.9% of the project area falls within the Northern Rockies Level III Ecoregion. The remaining 350 acres are isolated to the far northwestern corner of the project area and are classified as Canadian Rockies. According to the more detailed Level IV classification, 74% of the project area is identified as Salish Mountains. This ecoregion is typified as low forested mountains underlain by Precambian Belt Formations with volcanic ash on ridges and glacial till left by the Cordilleran Ice Sheet influencing slope hydrology. The extent and relative distribution of ecoregions is provided in **Table 2-4**. The second-most common ecoregion, Purcell-Cabinet-North Bitterroot Mountains, is dominant in the western portion of the project area. This ecoregion receives more precipitation than the Salish Mountains and is known for cedar-hemlock-pine forests. Peaks in the Cabinet Mountains are listed under the High Northern Rockies ecoregion and the Tobacco Plains and Stillwater-Swan Wooded Valley ecoregions are found surrounding the town of Rexford. The entire Kootenai-Fisher Project Area is influenced by Pacific moisture and has more diverse forests than elsewhere in Montana. **Appendix A, Figure A-11** maps the spatial extent of Level IV ecoregions.

Table 2-4. Ecoregion distribution in the Kootenai-Fisher Project Area

Level III Ecoregion	Level IV Ecoregion	Acres	Square Miles	% Total
Northern Rockies	Salish Mountains	1,182,631	1,848	73.8%
Northern Rockies	Purcell-Cabinet-North Bitterroot Mountains	312,584	488	19.5%
Northern Rockies	Stillwater-Swan Wooded Valley	49,831	78	3.1%
Northern Rockies	High Northern Rockies	44,123	69	2.8%
Northern Rockies	Tobacco Plains	12,034	19	0.8%
Canadian Rockies	Western Canadian Rockies	346	0.5	0.02%
Total		1,601,548	2,502	100%

2.2.2 Fire

Fire is a natural part of the Kootenai-Fisher ecosystem and many species have evolved to exist with the disturbance. For example, lodgepole pine developed serotinous cones that require heat from fires to open and disperse their seeds. It is well documented that fire suppression during the first half of the 20th century altered the natural fire regime in the western United States (National Wildfire Coordinating Group, 2012). Fire perimeters in the project area from 1889-2011 are shown in **Appendix A, Figure A-12**; however the impacts of fire suppression cannot be clearly distinguished in this figure.

Major stand replacing fires swept across the Kootenai-Fisher Project Area in 1910. In the aftermath, the Unites States Forest Service (USFS) adopted a practice of fire suppression for decades to come. The trend in acreage burned over the last century is displayed in **Figure 2-3**. In the last ten years 31,906 acres or 2% of the total project area has burned. The largest fire this decade was the 2007 Brush Creek fire and the most recent in available records occurred in 2011 when 174 acres burned near the confluence of the Fisher River and Wolf Creek.

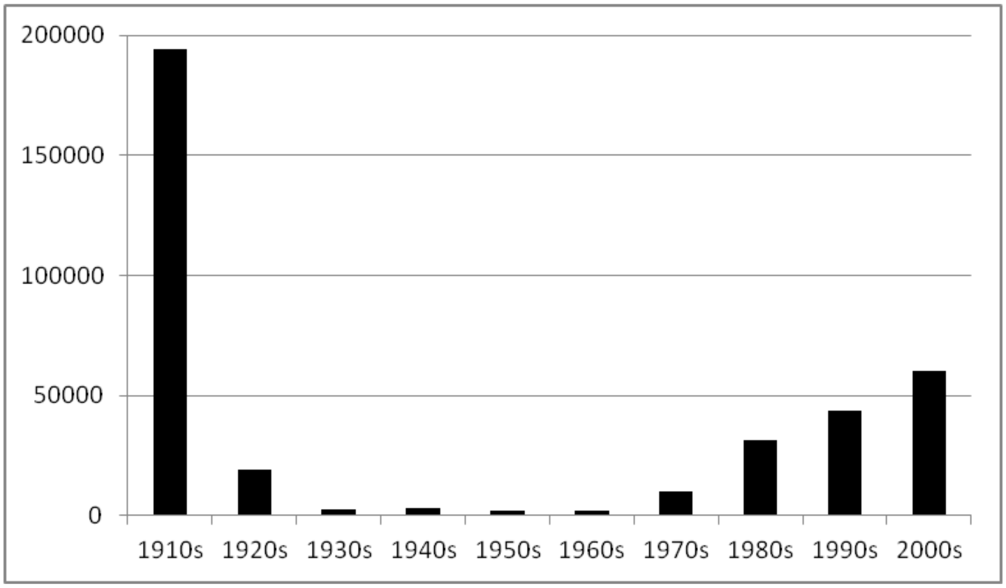

Figure 2-3. Estimated acreage burned in the Kootenai-Fisher Project Area per decade

2.2.3 Aquatic Life

There are numerous native fish species of concern present in the project area. Distributions are displayed in **Appendix A, Figure A-13** based on data provided by Montana Fish Wildlife and Parks (FWP) from 2010. The United States Fish and Wildlife Service (USFWS) lists two species on the federal Endangered Species Act: white sturgeon and bull trout. White sturgeon are limited to the Kootenai River within the project area.

Bull trout have been listed under the Endangered Species Act as threatened since 1998 due to habitat loss and degradation, introduction of non-native fish, fragmentation from dams and other barriers, and historical overharvesting. Bull trout populations in the Kootenai River are healthier than other Columbia River Basin populations however long-term monitoring has shown bull trout populations have declined since construction of the Libby Dam (U.S. Army Corps of Engineers, Seattle District, 2006). The species is acutely sensitive to environmental degradation because it requires cold, clean water. Bull trout spawn only in cobble/boulder substrate with sufficient groundwater upwelling to aerate eggs and low levels of silt to prevent smothering (Montana Department of Fish, Wildlife and Parks, 2012). While the dam impedes upstream migration, current operations consider bull trout by requiring minimum flows after spring sturgeon releases have been met and before flow augmentation for the fall spawning kokanee salmon starts in August. These minimum flows for bull trout avoid a double peaked hydrograph where large and rapid fluctuations in the wetted perimeter of the Kootenai River would be detrimental for fish habitat and water quality (U.S. Army Corps of Engineers, Seattle District, 2006). In 2000, the Plum Creek Timber Company finalized a 30-year agreement with the USFWS committing to specific conservation actions aimed at minimizing and mitigating impacts to bull trout from forest management activities on their land (Plum Creek Timber Co., 2000). An independent ten-year review indicated bull trout habitat has benefited from the partnership. Plum Creek's extensive work to date has included culvert replacement, stream channel restoration, and implementing best management practices. The Montana Department of Natural Resources and Conservation finalized a similar Native Fish Habitat Conservation Plan in 2010 (Montana Department of Natural Resources and Conservation, 2010) for activities on state trust land scattered across the project area.

The state of Montana also identifies torrent sculpin, Columbia Basin redband trout, westslope cutthroat trout and Yellowstone cutthroat trout as "species of concern" due to declining population trends, threats to their habitats, and/or restricted distribution. Cold, clean headwater streams in the Kootenai River drainage is the only place to find torrent sculpin in Montana, although their range extends into Washington, Oregon, and British Columbia. Native redband and cutthroat trout can hybridize and in some drainages of the Kootenai River these crosses are actually considered naturally occurring and historic; however, these three native species are threatened by their ability hybridize with introduced rainbow trout (Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, 2012). In 1979 the US Army Corps built the Murray Springs Fish Hatchery in Eureka to mitigate westslope cutthroat habitat loss as a result of the Libby Dam. The US Army Corps continues to fund the hatchery's operations which are run by Montana FWP (Montana Fish, Wildlife and Parks, 2013).

2.2.4 Terrestrial Life

The Kootenai-Fisher Project Area encompasses the range of several terrestrial species of concern. Two mammals have been listed as federally threatened: grizzly bears since 1975 and Canada lynx since 2000. The USFWS also identifies wolverine, whitebark pine, and spalding's catchfly (a flowering perennial plant) as candidate species for protection under the Endangered Species Act (U.S. Department of the Interior, Fish and Wildlife Service, 2012).

2.3 CULTURAL PARAMETERS

The flowing information describes the cultural profile of the Kootenai-Fisher Project Area and includes a discussion of population, transportation networks, land ownership, land cover/use, mining, and point sources.

2.3.1 Population

Native peoples migrated into the Kootenai-Fisher Project Area following the retreat of the Pinedale glaciation. The earliest found evidence of human inhabitants dates back 8,000 years (U.S. Forest Service, 2011). Members of the Kootenai and Salish Tribes consider the area part of their ancestral homeland. By the early 1800s European explorers and fur trappers frequented the region and used the Kootenai Valley as a travel route across the Continental Divide to the Columbia River. Miners flocked into the area starting in 1860s for a gold rush and mining precious metals continues to this day. See **Section 2.3.5** for more information on the history of mining in the project area. The next stage of European settlement revolved around the railroad. In the 1890s many men were employed harvesting timber for railroad ties. The first train hauling passengers and freight arrived to much fanfare in Libby on May 3, 1892. The railroad's existence opened the valley to the outside world and helped the region grow and prosper. In the 1900s the lumber and wood product industry grew to be a major sector of the economy. In the last 100 years the timber industry has gone through boom and bust cycles largely tied to the strength of the national housing and construction market. The recent trend has been downward. Since 1993 six lumber mills have closed in Lincoln County leaving only one mill still operating in Troy (City of Libby, 2010).

Today the Kootenai-Fisher Project Area is still very rural. According to the 2010 census, Lincoln County, which extends outside the boarders of the project area, had a population of 19,687 people. That equates to a county-wide average of 5.4 people per square mile. County demographics indicate roughly 20% of the population is under 18, another 20% is 65 or older and the majority (60%) falls within the 18 to 64 age class. Ninety-six percent of the population is white and the median household income is $30,800. The population of Lincoln County has risen 11% since 1980 and localized portions of the project area have experienced rapid development of formerly corporate timberlands (U.S. Forest Service, 2011).The population density of the project area is mapped on **Appendix A, Figure A-14**. As expected, the highest densities occur in the Libby, Troy, and greater Eureka areas. Libby is the county seat and the largest community with 2,628 people. Eureka, just outside the project boundary, had a population of 1,037 in 2010. Troy (938 people) and Rexford (105 people) complete the list of incorporated towns. The original Rexford town site was relocated 10 miles west during the construction of the Libby Dam. The nearest sizeable cities outside the project area are Kalispell, Montana (20 miles to the east) and Sand Point, Idaho (25 miles to the west).

2.3.2 Transportation Networks

US Highway 2 is a major transportation route which originates in the southeast corner of the project area near the Fisher River's headwaters, travels north to Libby and then turns west and follows the Kootenai River out of the project area past Troy. Montana Highway 56, also known as the Bull River Highway, begins off US Highway 2 near Troy and runs north-south. The Bull River Highway is the main route connecting Thompson Falls and Libby. Montana Highway 37 begins in Libby and traces the eastern side of Lake Koocanusa before ending at the US Interstate 93 junction slightly north of Eureka. At which point one can follow US 93 north to the international boarder at Roosville or south to Kalispell. Unpaved roads built for accessing timber stands are common. The network of unpaved roads on public and private lands will be further characterized as part of the sediment source assessment (**Section 5.5.3** and **Appendix D**).

An important rail transportation route enters the project area to the east and subsequently follows Wolf Creek, the Fisher River and the Kootenai River to Libby were it continues westward along the Kootenai River and US Highway 2. The tracks are owned by Burlington Northern Santa Fe which leases the transportation line to Amtrak as part of its Empire Builder route. Amtrak has one stop in project area at Libby. Troy, Eureka, and Libby also have small public airports.

2.3.3 Land Ownership

The Kootenai National Forest dominates the ownership landscape except in the southwestern portion of the project area where a checkerboard of public and private ownership exists. Ownership boundaries are shown in **Appendix A, Figure A-15** and detailed in **Table 2-5**. Public land ownership information was provided by the Montana Natural Heritage Program (2011). The extent of private timber lands was identified using the 2013 Montana Cadastral.

Table 2-5. Land ownership in the Kootenai-Fisher Project Area

Owner	Acres	Square Miles	% Total
U.S. Forest Service	1,054,820	1,648	66%
Private Timber Lands	349,882	546	22%
Other Private	146,598	230	9%
Montana State Trust Lands	39,668	62	2%
U.S. Fish and Wildlife Service	7,872	12	0.5%
Montana Fish, Wildlife and Parks	3,878	6	0.2%
U.S. Army Corps of Engineers	1,050	2	0.1%

The USFS is by far the largest land owner managing 66% of the total area. The project area encompasses three districts of the Kootenai National Forest: the entire Rexford Ranger District, most of the Libby Ranger District, and the southern portion of the Three Rivers Ranger District. The USFS manages its lands for sustainable forest harvest and resource extraction, a diverse array of recreational activities, the recovery of threatened and endangered species, and for overall ecological integrity (U.S. Forest Service, 2011). The newest version of the Kootenai Forest Plan explicitly lists as goals: to provide water quality to support beneficial uses, to support ecological function of riparian habitats, and to restore aquatic habitats where past management activities have affected stream channel morphology or wetland function (U.S. Forest Service, 2011). Congress designated 54,000 acres within the project area as wilderness in 1964 as part of the larger 94,000 acre Cabinet Mountains Wilderness Area.

Private timber companies are the second largest land holder. The overwhelming acreage of timber under both private and USFS ownership indicate the importance of timber harvest in the region. Remaining private lands are concentrated in the valley bottoms. Montana State Trust lands are scattered across 2% of the project area found mostly on 640 acre sections numbered 16 and 36, a relic of the framework which established them when Montana gained statehood in 1889. Other ownership categories account for less than 1%.

2.3.4 Land Cover and Use

Land cover within the project area is dominated by evergreen forests as indicated in **Table 2-6** and depicted in **Appendix A, Figure A-16**. The second most common land cover is shrub/scrub, as these two categories account for over 94% of the total area. The considerable size of Lake Koocanusa pushes the open water class to account for roughly 2% of the project area. Grassland/herbaceous is also represented on about 2% of the landscape. The other 14 land cover categories are rare and each account for less than half a percent. As previously discussed, developed areas are clustered around the towns of Libby, Troy, and Eureka. Human land use activities in the basin include silviculture, residential development, agriculture (primarily grazing and hay harvest), and road development/maintenance (forest roads, county roads, and private residential roads).

Table 2-6. Land cover distribution in the Kootenai-Fisher Project Area

Land Cover	Acres	Square Miles	% of Total
Evergreen Forest	1,200,983	1,876.5	74.97%
Shrub/Scrub	311,346	486.5	19.44%
Open Water	32,454	50.7	2.03%
Grassland/Herbaceous	29,108	45.5	1.82%

Table 2-6. Land cover distribution in the Kootenai-Fisher Project Area

Land Cover	Acres	Square Miles	% of Total
Developed, Open Space	5,750	9.0	0.36%
Emergent Herbaceous Wetlands	5,002	7.8	0.31%
Developed, Low Intensity	4,929	7.7	0.31%
Woody Wetlands	4,804	7.5	0.30%
Pasture/Hay	2,702	4.2	0.17%
Barren Land (Rock/Sand/Clay)	1,933	3.0	0.12%
Deciduous Forest	1,357	2.1	0.08%
Developed, Medium Intensity	1,262	2.0	0.08%
Cultivated Crops	586	0.9	0.04%
Perennial Ice/Snow	250	0.4	0.02%
Developed, High Intensity	53	0.1	0.00%
Mixed Forest	20	0.0	0.00%

2.3.5 Mining

Prospectors started exploring the Kootenai-Fisher Project Area in the 1860s. Successful returns from placer mines in Libby Creek lead to the establishment of a mining camp near the creek's mouth named Libbysville. Present-day Libby is just north of this original town site. Prospectors followed the source of these placer deposits upstream and a few decades later lode mines came into operation. Some evolved into sites with extensive underground workings and mills over the next 100 years.

The Kootenai-Fisher Project Area spans eight mining districts: Libby, Rainy Creek, Cabinet, Silver Butte, Sylvanite, Tobacco River, Troy, and Wolf Creek. MBMG's abandoned and inactive mines database estimates over 220 abandoned mines within the project area boundary. The Department of Environmental Quality's (DEQ) abandoned mine inventory has information on 76 mines. These sites are mapped on **Appendix A, Figure A-17** and operations predominately mined for precious metals although some quarries produced rock, gravel or sand. Commodities that drove production and exploration include gold, copper, silver, and lead.

The state of Montana identifies two sites in the Kootenai-Fisher Project Area as high priority abandoned mines. This distinction helps facilitate site cleanup by ranking them according to the public health risk. The Snowshoe Mine was originally ranked number 47 on the priority abandoned mines list until it was reclaimed by DEQ's Mine Waste Cleanup Bureau over a three year period ending in 2010. Historically, the Snowshoe Mine was the most prolific lode producer in the region and went through sporadic periods of production from 1889 through the 1960s. After the Snowshoe Mine closed, waste rock and mill tailings left in the floodplain contaminated the sediment and water quality of the Snowshoe Creek with heavy metals. The reclamation effort removed this waste from the immediate vicinity surrounding the mine and mill to a capped repository three miles away. DEQ also replaced floodplain wastes with clean, seeded soil and reconstructed the Snowshoe Creek channel (Pioneer Technical Services, Inc., 2010). A significant amount of tailings remain in the stream channel downstream of the mine site.

The second high priority abandoned mine in the project area is the Cherry Creek Mill site. The site, located 10 miles south of Libby and only 50 feet from Big Cherry Creek, was originally ranked number 100 by DEQ but because it is located on the Kootenai National Forest, reclamation duties were referred to the USFS. MBMG investigations report the Cherry Creek Mill was established to process tailings from the Snowshoe Mine because Cherry Creek was a more consistent water source (Hargrave et al., 1999a). The mill operated from 1958-1967. When DEQ investigated the site in 1993, approximately 4,500 cubic yards of moderately vegetated mill tailings remained at the site with elevated levels of heavy metals and cyanide (Pioneer Technical Services, Inc., 1995). Because no mining activities took place at the site there are no adits or mine shafts. Prior to 1993 the site was recontoured and reseeded, although detailed records of these activities could not be found.

The Big Cherry mill site has undergone significant reclamation. The Big Cherry Mill site originally contained approximately 3,600 bank cubic yards of waste that was a significant source of metals pollution. Downstream of the Mill site and adjacent to Big Cherry Creek another mine waste deposit area contained approximately 3,900 bank cubic yards of contaminated material which originated at the Snowshoe Mine. Reclamation activities include excavation of a total of about 10,455 bcy of material (including 6-12 inches of native underlying material) that was excavated from these areas and securely placed in an onsite repository. Clean soil was obtained from a local source on NFS (National Forest Service) land to backfill and blend the area with surrounding topography. The area has been reclaimed with native vegetation and seedlings. In 2010, approximately 700 cyd of amended material was brought to the Mill site location to improve vegetation, the area was again seeded and mulched.

The project area has one permitted hard rock mine (the Troy Mine) and another in the planning stages (the Montanore Mine) (U.S. Forest Service, 2011). The Troy ore body was discovered in the early 1960s, developed and mined by the American Smelting and Refining Company (ASARCO) from 1980 to 1993 and then brought back into production by a new owner, Revett Minerals, Inc., in 2004 (Revett Mining, 2012). Mining operations are located in the Stanley Creek (currently listed as impaired by copper) drainage south of the town of Troy and two miles west of Bull Lake and Highway 56. Revett Minerals expanded operations from 2004 through 2012 while producing 8.4 million ounces of silver and 69.5 million ounces of copper (Revett Mining, 2012). However in December 2012 a ceiling collapse in part of the underground workings blocked access to the surface. At this time production has stalled and a majority of the workforce has been laid off until access can be reestablished and safety inspections completed (Anon. 6/28/2013). The company anticipates reopening the Troy Mine in late 2014 with full production back online the following year (Associated Press, 10/19/2013). Revett Minerals Inc. is also operating under an exploratory license (#00663) while working through the application process for an operating permit at the Rock Creek Mine site, located just 16 miles southeast of the Troy Mine.

Operations at the Montanore Mine are located on the eastern slope of the Cabinet Mountains in the headwaters region of Libby Creek. Proposed workings would follow an ore body extending outside the project area. Mines Management Inc. is progressing through environmental review steps as required by the National Environmental Protection Act to obtain an operating license and move from an exploration phase into a production phase. The application has been delayed and created controversy due to the fact that the mine proposes to extract minerals from a federally designated wilderness area. Lastly, a vermiculite mine located in the Rainy Creek drainage northeast of Libby was operational for 70 years before closing in 1990. The vermiculite mine and its associated asbestos contamination has left the region a lasting legacy.

2.3.6 Point Sources

There are roughly 25 active point sources permitted under the Montana Pollutant Discharge Elimination System (MPDES) in the Kootenai-Fisher Project Area according to the Environmental Protection Agency's (EPA) Integrated Compliance Information System database as of September 2013. Many of these point sources discharge into either non-impaired waterways or waterbodies not investigated as part of this

TMDL project. Thus this discussion of point sources is limited to the 14 permits in the Libby Creek watershed depicted in **Appendix A, Figure A-18** which have the ability to affect TMDL streams.

Twelve of these permits are general permits to operate suction dredges, which are mechanical devices that float on the stream surface and pump stream water and stream bed material through a suction dredge intake to a sluice box, from which gold or other precious metals are recovered. Unwanted gravels and other naturally occurring stream bottom material fall off the end of the sluice box and are redeposited onto the stream bottom. Since the discharge consists of naturally occurring stream bottom material and no chemicals are allowed to be added to enhance gold recovery, the main concern from these operations in terms of TMDL development is sediment loading. Limitations contained in the general permit help address this concern by prohibiting a visual increase in turbidity at the end of a mixing zone.

The other two MPDES permits are held by Montanore Minerals Corporation: one is a general permit for stormwater discharges associated with construction activities (MTR104874) and the other is an individual permit for discharges related to mining operations at the Montanore Mine (MT0030279). The stormwater construction permit is associated with work at the Libby Creek adit site and is required because the surface disturbance is equal to or greater than one acre. Similar to the suction dredge operations, sediment is the pollutant of concern at this construction site from a stream loading perspective and following the conditions contained in the permit will help address sediment loading from this source. The mine's individual permit contains sediment, metals, and nutrient effluent limitation for three outfalls discharging to groundwater and Libby Creek.

3.0 MONTANA WATER QUALITY STANDARDS

The federal Clean Water Act provides for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's surface waters so that they support all designated uses. Water quality standards are used to determine impairment, establish water quality targets, and to formulate the TMDLs and allocations.

Montana's water quality standards and water quality standards in general include three main parts:
1. Stream classifications and designated uses
2. Numeric and narrative water quality criteria designed to protect designated uses
3. Nondegradation provisions for existing high-quality waters

Montana's water quality standards also incorporate prohibitions against water quality degradation as well as point source permitting and other water quality protection requirements.

Nondegradation provisions are not applicable to the TMDLs developed within this document because of the impaired nature of the streams addressed. Those water quality standards that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards may be found in the Montana Water Quality Act (75-5-301,302 Montana Code Annotated (MCA)), and Montana's Surface Water Quality Standards and Procedures (Administrative Rules of Montana (ARM) 17.30.601-670) and Circular DEQ-7 (Montana Department of Environmental Quality, 2012a).

3.1 STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. All streams and lakes within the Kootenai-Fisher TMDL Project are classified as B-1, which specifies that the water must be maintained suitable to support all of the following uses ((Administrative Rules of Montana (ARM) (17.30.623(1), State of Montana, 2014):

- Drinking, culinary, and food processing purposes, after conventional treatment (Drinking Water)
- Bathing, swimming, and recreation (Primary Contact Recreation)
- Growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers (Aquatic Life)
- Agricultural and industrial water supply

While some of the waterbodies might not actually be used for a designated use (e.g., drinking water supply), their water quality still must be maintained suitable for that designated use. More detailed descriptions of Montana's surface water classifications and designated uses are provided in **Appendix B**. DEQ's water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant group addressed within this document, thus ensuring protection of all designated uses (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011b). For streams in Western Montana, the most sensitive use assessed for sediment is aquatic life; for temperature is aquatic life; for metals are drinking water and/or aquatic life; and for nutrients is aquatic life and primary contact recreation. DEQ determined that seven waterbody segments in the Kootenai-Fisher Project Area do not meet the sediment, temperature, metals, and/or nutrients water quality standards (**Table 3-1**).

Table 3-1. Impaired Waterbodies and their Impaired Designated Uses in the Kootenai-Fisher TMDL Project Area

Waterbody & Location Description	Waterbody ID	Impairment Cause [1]	Impaired Use(s)
BIG CHERRY CREEK, Snowshoe Creek to mouth (Libby Creek)	MT76D002_050	Cadmium	Aquatic Life
		Lead	Aquatic Life
		Zinc	Aquatic Life
LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)	MT76D002_070	Copper	Aquatic Life
		Lead	Aquatic Life
		Nitrate + Nitrite	Aquatic Life Primary Contact Recreation
		Sediment / Siltation	Aquatic life
LIBBY CREEK, Highway 2 bridge to mouth (Kootenai River)	MT76D002_062	Sediment / Siltation	Aquatic life
RAVEN CREEK, Headwaters to mouth (Pleasant Valley Fisher River)	MT76C001_030	Total Phosphorus	Aquatic life Primary Contact Recreation
		Sediment / Siltation	Aquatic Life
SNOWSHOE CREEK, Cabinet Wilderness boundary to mouth (Big Cherry Creek)	MT76D002_040	Arsenic	Drinking Water
		Cadmium	Aquatic Life Drinking Water
		Lead	Aquatic Life Drinking Water
		Zinc	Aquatic Life
STANLEY CREEK, Headwaters to mouth (Lake Creek) [2]	MT76D002_010	Copper	Aquatic Life
		Lead	Aquatic Life
		Zinc	Aquatic Life
		Nitrate + Nitrite	Aquatic life Primary Contact Recreation
WOLF CREEK, Headwaters to mouth (Fisher River)	MT76C001_020	Sediment / Siltation	Aquatic Life
		Temperature	Aquatic Life

[1] Only includes those pollutant impairments addressed by TMDLs in this document

[2] The Stanley Creek waterbody segment location description reads as “Stanley Creek, headwaters to confluence with Fairway Creek” in the 2012 Integrated Report. The segment was extended to the confluence with Lake Creek and the new description will be reflected in the 2014 Integrated Report.

3.2 NUMERIC AND NARRATIVE WATER QUALITY STANDARDS

In addition to the use classifications described above, Montana’s water quality standards include numeric and narrative criteria that protect the designated uses. Numeric criteria define the allowable concentrations, frequency, and duration of specific pollutants so as not to impair designated uses.

Numeric standards apply to pollutants that are known to have adverse effects on human health or aquatic life (e.g., metals, organic chemicals, and other toxic constituents). Human health standards are set at levels that protect against long-term (lifelong) exposure via drinking water and other pathways such as fish consumption, as well as short-term exposure through direct contact such as swimming.

Numeric standards for aquatic life include chronic and acute values. Chronic aquatic life standards prevent long-term, low level exposure to pollutants. Acute aquatic life standards protect from short-term exposure to pollutants. Numeric standards also apply to other designated uses such as protecting irrigation and stock water quality for agriculture.

Narrative standards are developed when there is insufficient information to develop numeric standards and/or the natural variability makes it impractical to develop numeric standards. Narrative standards describe the allowable or desired condition. This condition is often defined as an allowable increase above “naturally occurring.” DEQ often uses the naturally occurring condition, called a “reference condition,” to help determine whether or not narrative standards are being met (see **Appendix B**).

For the Kootenai-Fisher Project Area, a combination of numeric and narrative standards are applicable. The numeric standards apply to metals, and narrative standards are applicable for sediment, temperature, and nutrients, as well as metals. The specific numeric and narrative standards are summarized in **Appendix B**.

4.0 DEFINING TMDLS AND THEIR COMPONENTS

A total maximum daily load (TMDL) is a tool for implementing water quality standards and is based on the relationship between pollutant sources and water quality conditions. More specifically, a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive from all sources and still meet water quality standards.

Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are discernible, confined and discrete conveyances, such as pipes, ditches, wells, containers, or concentrated animal feeding operations, from which pollutants are being, or may be, discharged. Some sources such as return flows from irrigated agriculture are not included in this definition. All other pollutant loading sources are considered nonpoint sources. Nonpoint sources are diffuse and are typically associated with runoff, streambank erosion, most agricultural activities, atmospheric deposition, and groundwater seepage. Natural background loading is a type of nonpoint source.

As part of TMDL development, the allowable load is divided among all significant contributing point and nonpoint sources. For point sources, the allocated loads are called “wasteload allocations” (WLAs). For nonpoint sources, the allocated loads are called “load allocations” (LAs).

A TMDL is expressed by the equation: $\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA}$, where:

ΣWLA is the sum of the wasteload allocation(s) (point sources)
ΣLA is the sum of the load allocation(s) (nonpoint sources)

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation. Alternatively, the MOS can be implicit in the TMDL. A TMDL must also ensure that the waterbody will be able to meet and maintain water quality standards for all applicable seasonal variations (e.g., pollutant loading or use protection).

Development of each TMDL has four major components:

- Determining water quality targets
- Quantifying pollutant sources
- Establishing the total allowable pollutant load
- Allocating the total allowable pollutant load to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs, regardless of pollutant. Each component is described in further detail in the following subsections.

Figure 4-1 illustrates how numerous sources contribute to the existing load and how the TMDL is defined. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

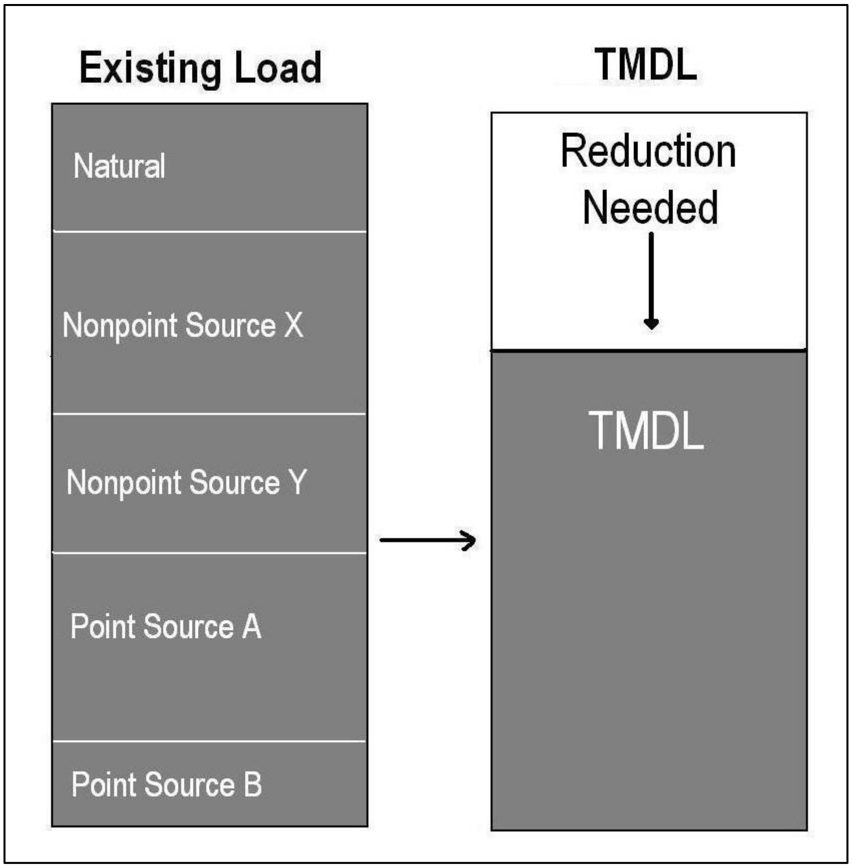

Figure 4-1. Schematic Example of TMDL Development

4.1 DEVELOPING WATER QUALITY TARGETS

TMDL water quality targets are a translation of the applicable numeric or narrative water quality standard(s) for each pollutant. For pollutants with established numeric water quality standards, the numeric value(s) are used as the TMDL targets. For pollutants with narrative water quality standard(s), the targets provide a waterbody-specific interpretation of the narrative standard(s).

Water quality targets are typically developed for multiple parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s). Therefore, the targets provide a benchmark by which to evaluate attainment of water quality standards. Furthermore, comparing existing stream conditions to target values allows for a better understanding of the extent and severity of the problem.

4.2 QUANTIFYING POLLUTANT SOURCES

All significant pollutant sources, including natural background loading, are quantified so that the relative pollutant contributions can be determined. Because the effects of pollutants on water quality can vary throughout the year, assessing pollutant sources must include an evaluation of the seasonal variability of the pollutant loading. The source assessment helps to define the extent of the problem by linking the pollutant load to specific sources in the watershed.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Nonpoint sources are quantified by source categories (e.g., unpaved roads, mining) and/or by land uses (e.g., crop production, timber harvest). These source categories and land uses can be divided further by ownership, such as federal, state, or private. Alternatively, most, or all, pollutant sources in a sub-watershed or source area can be combined for quantification purposes.

Because all potentially significant sources of the water quality problems must be evaluated, source assessments are conducted on a watershed scale. The source quantification approach may produce reasonably accurate estimates or gross allotments, depending on the data available and the techniques used for predicting the loading (40 Code of Federal Regulations (CFR) Section 130.2(I)). Montana TMDL development often includes a combination of approaches, depending on the level of desired certainty for setting allocations and guiding implementation activities.

4.3 ESTABLISHING THE TOTAL ALLOWABLE LOAD

Identifying the TMDL requires a determination of the total allowable load over the appropriate time period necessary to comply with the applicable water quality standard(s). Although a “TMDL” is specifically defined as a “daily load,” determining a daily loading may not be consistent with the applicable water quality standard(s), or may not be practical from a water quality management perspective. Therefore, the TMDL will ultimately be defined as the total allowable loading during a time period that is appropriate for applying the water quality standard(s) and which is consistent with established approaches to properly characterize, quantify, and manage pollutant sources in a given watershed. For example, sediment TMDLs may be expressed as an allowable annual load.

If a stream is impaired by a pollutant for which numeric water quality criteria exist, the TMDL, or allowable load, is typically calculated as a function of streamflow and the numeric criteria. This same approach can be applied when a numeric target is developed to interpret a narrative standard.

Some narrative standards, such as those for sediment, often have a suite of targets. In many of these situations it is difficult to link the desired target values to highly variable, and often episodic, instream loading conditions. In such cases the TMDL is often expressed as a percent reduction in total loading based on source quantification results and an evaluation of load reduction potential (**Figure 4-1**). The degree by which existing conditions exceed desired target values can also be used to justify a percent reduction value for a TMDL.

Even if the TMDL is preferably expressed using a time period other than daily, an allowable daily loading rate will also be calculated to meet specific requirements of the federal Clean Water Act. Where this occurs, TMDL implementation and the development of allocations will still be based on the preferred time period, as noted above.

4.4 DETERMINING POLLUTANT ALLOCATIONS

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources. The allocations are often determined by quantifying feasible and achievable load reductions through application of a variety of best management practices and other reasonable conservation practices.

Under the current regulatory framework (40 CFR 130.2) for developing TMDLs, flexibility is allowed in allocations in that “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure." Allocations are typically expressed as a number, a percent reduction (from the current load), or as a surrogate measure (e.g., a percent increase in canopy density for temperature TMDLs).

Figure 4-2 illustrates how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Although some flexibility in allocations is possible, the sum of all allocations must meet the water quality standards in all segments of the waterbody.

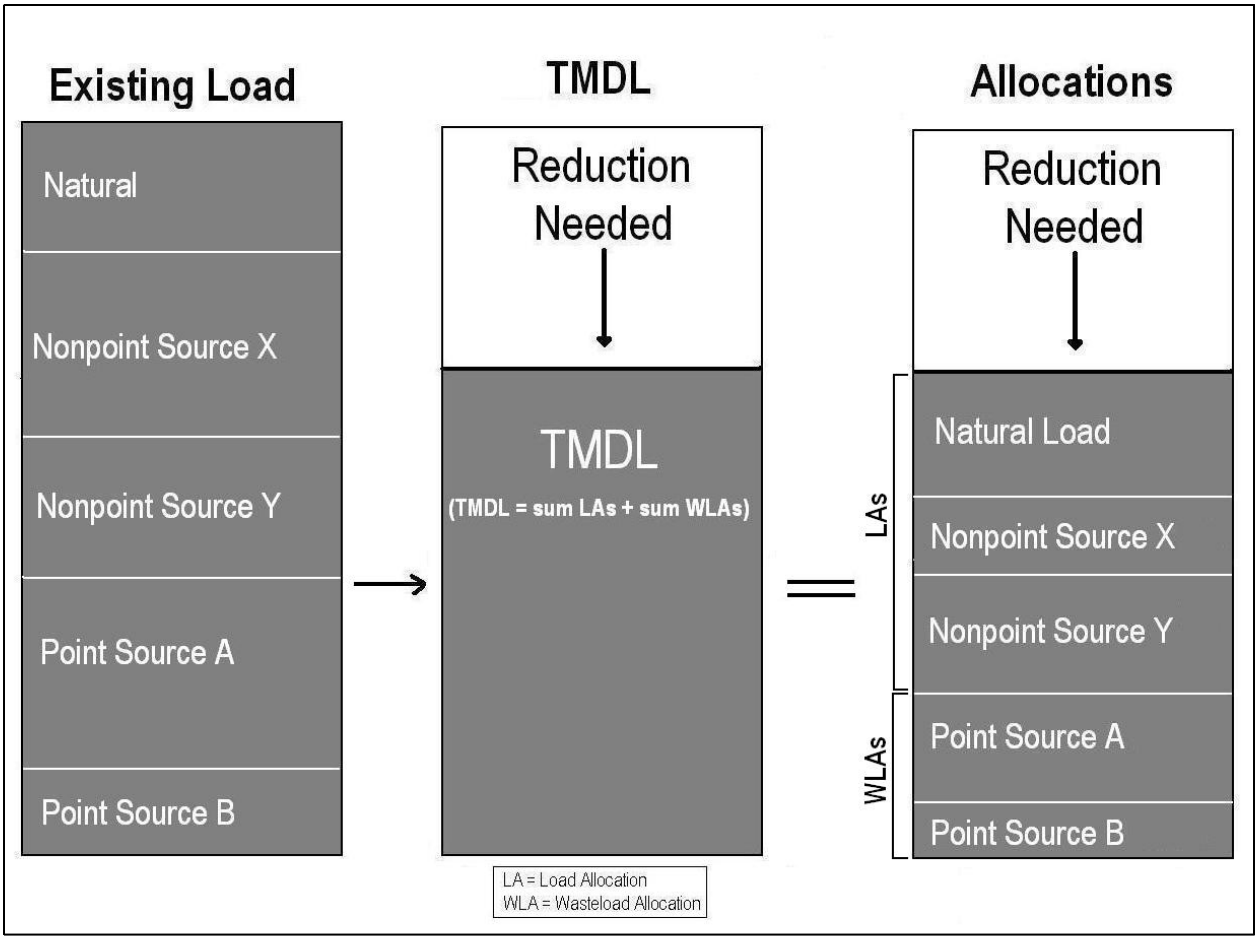

Figure 4-2. Schematic Diagram of a TMDL and its Allocations

TMDLs must also incorporate a margin of safety. The margin of safety accounts for the uncertainty, or any lack of knowledge, about the relationship between the pollutant loads and the quality of the receiving waterbody. The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process, or explicitly by setting aside a portion of the allowable loading (i.e., a TMDL = WLA + LA + MOS) (U.S. Environmental Protection Agency, 1999b). The margin of safety is a required component to help ensure that water quality standards will be met when all allocations are achieved. In Montana, TMDLs typically incorporate implicit margins of safety.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. For TMDLs in this document where there is a combination of nonpoint sources and one or more permitted point sources discharging into an impaired stream reach, the permitted point source WLAs are not dependent on implementation of the LAs. Instead, DEQ sets the WLAs and LAs at levels necessary to achieve water quality standards throughout the watershed. Under these conditions, the LAs are developed independently of the permitted point source WLA such that they would satisfy the TMDL target concentration within the stream reach immediately above the point source. In order to ensure that the water quality standard or target concentration is achieved below the point source discharge, the WLA is based on the point source's discharge concentration set equal to the standard or target concentration for each pollutant.

4.5 IMPLEMENTING TMDL ALLOCATIONS

The Clean Water Act (CWA) and Montana state law (Section 75-5-703 of the Montana Water Quality Act) require wasteload allocations to be incorporated into appropriate discharge permits, thereby providing a regulatory mechanism to achieve load reductions from point sources. Nonpoint source reductions linked to load allocations are not required by the CWA or Montana statute, and are primarily implemented through voluntary measures. This document contains several key components to assist stakeholders in implementing nonpoint source controls. **Section 10.0** provides a water quality improvement plan that discusses restoration strategies by pollutant group and source category, and provides recommended best management practices (BMPs) per source category (e.g., urban development, unpaved roads, timber harvest, grazing, cropland, etc.). **Section 10.6** discusses potential funding sources that stakeholders can use to implement BMPs for nonpoint sources. Other site-specific pollutant sources are discussed throughout the document, and can be used to target implementation activities. DEQ's Watershed Protection Section (Nonpoint Source Program) helps to coordinate water quality improvement projects for nonpoint sources of pollution throughout the state and provides resources to stakeholders to assist in nonpoint source BMPs. Montana's Nonpoint Source Management Plan (available at http://www.deq.mt.gov/ wqinfo/nonpoint/nonpointsourceprogram.mcpx) further discusses nonpoint source implementation strategies at the state level.

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 11.0**). This includes a monitoring strategy and an implementation review that is required by Montana statute (75-5-703, Montana Code Annotated). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

5.0 SEDIMENT TMDL COMPONENTS

This portion of the document focuses on sediment as a cause of water quality impairment in the Kootenai-Fisher TMDL Project Area. It describes: (1) how excess sediment impairs beneficial uses, (2) the affected stream segments, (3) the currently available data pertaining to sediment impairments in the watershed, (4) the sources of sediment based on recent studies, and (5) the proposed sediment TMDLs and their rationales.

5.1 EFFECTS OF EXCESS SEDIMENT ON BENEFICIAL USES

Sediment is a naturally occurring component of healthy and stable stream and lake ecosystems. Regular flooding allows sediment deposition to build floodplain soils and point bars, and it prevents excess scour of the stream channel. Riparian and wetland vegetation and natural instream barriers such as large woody debris (LWD), beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent or excessive sediment loading enters the system from increased bank erosion or other sources, it may alter channel form and function and affect fish and other aquatic life by increasing turbidity and causing excess sediment to accumulate in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

More specifically, sediment may block light and cause a decline in primary production, and it may also interfere with fish and macroinvertebrate survival and reproduction. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. Effects from excess sediment are not limited to suspended or fine sediment; an accumulation of larger sediment (e.g., cobbles) can fill pools, reduce the percentage of desirable particle sizes for fish spawning, and cause channel overwidening (which may lead to additional sediment loading and/or increased temperatures). This larger sediment can also reduce or eliminate flow in some stream reaches where sediment aggrades within the channel, causing flow to go subsurface (May and Lee, 2004). Although fish and aquatic life are typically the most sensitive beneficial uses regarding sediment, excess sediment may also affect other uses. For instance, high concentrations of suspended sediment in streams can also cause water to appear murky and discolored, negatively impacting recreational use, and excessive sediment can increase filtration costs for water treatment facilities that provide safe drinking water.

5.2 STREAM SEGMENTS OF CONCERN

A total of six waterbody segments in the Kootenai-Fisher project area appeared on the 2012 Montana 303(d) List for sediment impairments (**Figure 5-1**): Bristow, Libby, Lake, Quartz, Raven, and Wolf Creeks. All but Bristow and Lake Creeks are also impaired for various forms of habitat alterations (**Appendix A, Table A-1**), which are non-pollutant causes commonly associated with sediment impairment. TMDLs are limited to pollutants, but implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some non-pollutant impairments.

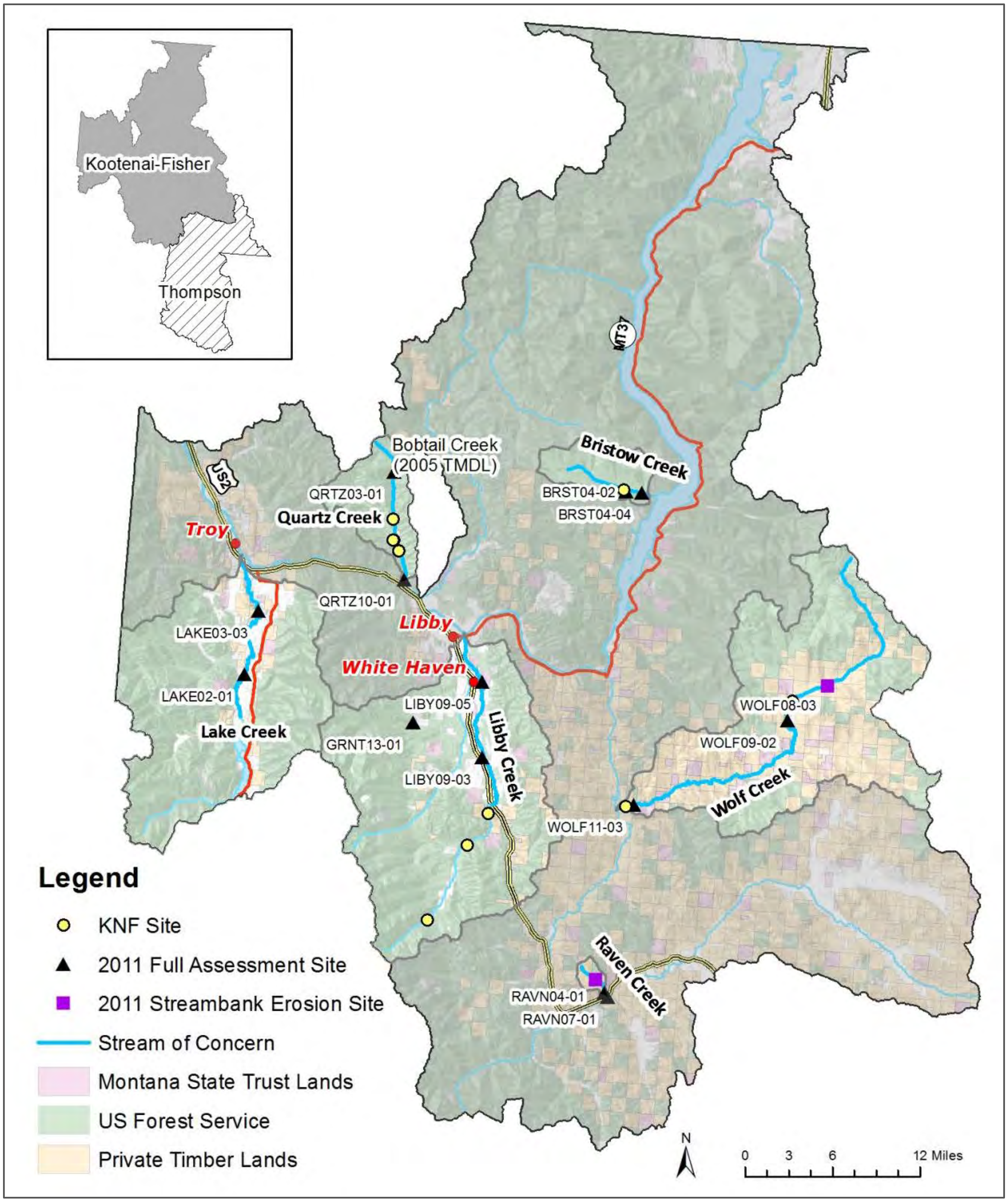

Figure 5-1. Sediment streams of concern and sampling sites in the Kootenai-Fisher Project Area

5.3 INFORMATION SOURCES AND ASSESSMENT METHODS

For TMDL development, information sources and assessment methods fall within two general categories. The first category, discussed within this section, is focused on characterizing overall stream health with focus on sediment and related water quality conditions. The second category, discussed within **Section 5.5**, is focused on quantifying sources of sediment loading within the watershed.

5.3.1 Summary of Information Sources

To characterize sediment conditions for TMDL development purposes, a sediment data compilation was completed and additional monitoring was performed during 2011. The below listed data sources represent the primary information used to characterize water quality and/or develop TMDL targets.

- DEQ Assessment Files
- EPA 2011 Sediment and Habitat Assessments
- Kootenai National Forest Data
- Relevant Local and Regional Reference Data
- Other Data and Reports

5.3.2 DEQ Assessment Files

The DEQ assessment files contain information used to make the existing sediment impairment determinations. The files include a summary of physical, biological, and habitat data collected and/or compiled by DEQ. The files also include information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationale.

5.3.3 EPA's 2011 Sediment and Habitat Assessments

To aid in TMDL development, field measurements of channel morphology and riparian and instream habitat parameters were collected in August 2011 from 13 reaches (**Figure 5-1**). An additional two reaches were assessed in 2011 (denoted as bank erosion hazard index (BEHI) sites in **Figure 5-1**) to determine the severity of bank erosion and identify the source. Reaches were dispersed among the 6 segments of concern listed in **Section 5.2**, with two full assessment reaches on all streams and an additional reach on Granite Creek to broaden the range of conditions in the sample dataset and serve as a potential reference site.

Initially, all streams were assessed aerially to characterize reaches by four main attributes not linked to human activity: stream order, valley gradient, valley confinement, and ecoregion. These attributes represent main factors influencing stream morphology, which in turn influence sediment transport and deposition.

The next step in the aerial assessment involved identifying near-stream land uses, since land management practices can have a significant influence on stream morphology and sediment characteristics. The result was stratifying streams into reaches that allow for comparisons among those reaches of the same natural morphological characteristics, while also indicating stream reaches where land management practices may further influence stream morphology. The stream stratification, along with field reconnaissance, allowed DEQ to select the above-referenced monitoring reaches. Although ownership is not part of the reach type category (because of the distribution of private and federal land within the watershed), most reach type categories contain predominantly either private or public lands.

Monitoring reaches on sediment-listed streams were chosen to represent various reach characteristics, land-use categories, and human-caused influences. There was a preference toward sampling those reaches where human influences would most likely lead to impairment conditions, since one step in the TMDL development process is to further characterize sediment impairment conditions. Thus, it is not a random sampling design intended to sample stream reaches representing all potential impairment and non-impairment conditions. Instead, it is a targeted sampling design that aims to assess a representative subset of reach types, while ensuring that reaches within each 303(d) listed waterbody with potential sediment impairment conditions are incorporated into the overall evaluation. Typically, the effects of excess sediment are most apparent in low-gradient, unconfined streams larger than 1st order (i.e., having at least one tributary); therefore, this stream type was the focus of the field effort (**Table 5-1**). Although the TMDL development process necessitates this targeted sampling design, DEQ acknowledges this approach results in less certainty regarding conditions in 1st order streams and higher-gradient reaches, and that conditions within sampled reaches do not necessarily represent conditions throughout the entire stream.

Table 5-1. Stratified Reach Types and Sampling Site Representativeness within the Kootenai-Fisher Project Area

Reach Type	Number of Reaches	Number of Monitoring Sites	Monitoring Sites
NR-0-3-C	4		
NR-0-3-U	12	1	QRTZ10-01
NR-0-4-U	29	8	GRNT13-01, LAKE02-01, LAKE03-03, LIBY09-03, LIBY09-05, WOLF08-03*, WOLF09-02, WOLF11-03
NR-0-5-U	1		
NR-10-1-C	1		
NR-10-1-U	3		
NR-10-2-C	1		
NR-2-1-C	1		
NR-2-1-U	2		
NR-2-2-C	1	1	QRTZ03-01
NR-2-2-U	7	1	RAVN07-01
NR-2-3-C	1		
NR-2-3-U	9	2	BRST04-02, BRST04-04
NR-2-4-C	1		
NR-2-4-U	2		
NR-4-1-U	1	1	RAVN04-01*
NR-4-2-C	2		
NR-4-2-U	4	1	RAVN06-01
NR-4-3-U	2		
Total	**84**	**15**	

*Streambank erosion assessment only

The field parameters assessed in 2011 include standard measures of stream channel morphology, fine sediment, stream habitat, riparian vegetation, and streambank erosion (Montana Department of Environmental Quality, 2011a). Although the sampling areas are frequently referred to as “sites” within this document, to help increase sample sizes and capture variability within assessed streams, they were actually sampling reaches ranging from 500 to 2,000 feet (depending on the channel bankfull width) that were broken into five cells of equal length. Generally, a single cross section measurement, pebble count, and riffle grid toss are performed in each cell, and stream habitat, riparian, and bank erosion measures are performed throughout the reach. Field parameters are briefly described in **Section 5.4**, and summaries of all field data and sampling protocols are contained in the 2011 Sediment and Habitat Assessment report (**Attachment A**).

5.3.4 Kootenai National Forest Monitoring Data

The Libby District of the Kootenai National Forest (KNF) routinely collects streamflow, suspended sediment, physical, and biological monitoring data on streams throughout its district, which includes all sediment streams of concern except Lake Creek (i.e., Bristow, Libby, Quartz, Raven, and Wolf). Lake Creek is in the Three Rivers District, and most of land along it is private; USFS data in the Lake Creek watershed is limited to tributary watersheds that are managed by the USFS. For the purpose of evaluating current conditions, Rosgen channel morphology, pool and wood habitat, McNeill core data, and macroinvertebrate data from the previous 10 years were compiled. Core and macroinvertebrate data exist for most streams but only one site on Wolf Creek had channel morphology and habitat data collected within the past 10 years.

DEQ does not typically collect core samples but all data included in the data evaluation except the macroinvertebrate data were collected with similar protocols as those used by EPA in 2011. Channel morphology measurements followed Rosgen's method (Rosgen, 1996), pool and wood measurements followed the USFS R1/R4 fish habitat inventory procedures (Overton et al., 1997), and core samples were collected following standard protocols (McNeil and Ahnell, 1964). Macroinvertebrate samples were collected with a Hess or Surber sampler in pool and riffle habitat; effects of the methodology difference are discussed relative to "Biological Indices" in **Section 5.4.1.6**. Suspended sediment data and streamflow can be helpful for tracking suspended loads over the long term, or evaluating changes resulting from landscape disturbances but were not obtained from the Libby District for this project because the TMDL will not be based on instream sediment loads or include a suspended sediment target.

5.3.5 Relevant Local and Regional Reference Data

Regional reference data was derived from KNF reference sites and the PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO). There is reference data for channel morphology parameters (i.e., width/depth and entrenchment) for 151 sites assessed within all districts of the KNF between 1992 and 1999 and then a more extensive reference dataset (i.e., channel morphology, fine sediment, and habitat measures) for 77 sites within the Libby District collected between 1995 and 2004. The Libby District lies entirely within the Northern Rockies (Level III ecoregion) and Salish Mountains (Level IV ecoregion). The PIBO reference dataset (http://www.fs.fed.us/biology/fishecology/emp/) includes USFS and Bureau of Land Management (BLM) sites throughout the Pacific Northwest, but to increase the comparability of the data to conditions in the Kootenai-Fisher project area, only data collected within the Northern Rockies ecoregion were evaluated. Between 2001 and 2012, 72 PIBO sites have been established in the Northern Rockies, and several of the sites have been visited more than once (n=109). Eleven of the PIBO reference sites are located in the Kootenai National Forest. Much of the PIBO sampling protocol (Heitke et al., 2012) is similar to the DEQ protocol used by EPA in 2011; the methodologies are discussed in more detail within this section for any PIBO parameters considered for water quality targets.

5.3.6 Other Data and Reports

Several other documents that provide historical context to sediment sources, describe the sensitivity of watersheds to disturbance, and provide information about current conditions or sources were also used to help evaluate conditions within the stream segments of concern. These documents include: the Upper Kootenai Subbasin Review (U.S. Department of Agriculture, Forest Service, 2002); a thesis that evaluated the causes of instability in Libby Creek (Sato, 2000); KNF ecosystem and travel analysis reports (USDA Forest Service, 2007; USDA Forest Service, 2009a; USDA Forest Service, 2009b); and numerous National Environmental Policy Act (NEPA) documents for projects within the Bristow, Lake, Libby, Quartz, Raven, and Wolf watersheds (U.S. Department of Agriculture, Forest Service, 2003; Altman, 1990; Edwards, 2008; U.S. Department of Agriculture, Forest Service, Kootenai National Forest and

Montana Department of Environmental Quality, 2009; U.S. Forest Service and Montana Department of Environmental Quality, 2012; USDA Forest Service, Kootenai National Forest (KNF), 2010; USDA Forest Service, Kootenai National Forest (KNF), 2012; USDA Forest Service, Kootenai National Forest (KNF) and Montana Department of Environmental Quality, 2011). Additionally, for Quartz Creek there are several studies investigating the delta at the mouth (Zelch, 2003; Dibrani, 2003; Sylvester and Stephens, 2013) as well as a post restoration monitoring report by the KNF (Wegner, 1998).

5.4 WATER QUALITY TARGETS

The concept of water quality targets was presented in **Section 4.1**. This section provides the rationale for each sediment-related target parameter and discusses the basis of the target values.

In developing targets, natural variation within and among streams must be considered. As discussed in more detail in **Section 3.0** and **Appendix B**, DEQ uses the reference condition to gage natural variability and assess the effects of pollutants with narrative standards, such as sediment. The preferred approach to establishing the reference condition is using reference site data, but modeling, professional judgment, and literature values may also be used. DEQ defines “reference” as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, the reference condition reflects a waterbody’s greatest potential for water quality given past and current land use. Although sediment water quality targets typically relate most directly to the aquatic life use, the targets protect all designated beneficial uses because they are based on the reference approach, which strives for the highest achievable condition.

Waterbodies used to determine reference conditions are not necessarily pristine. The reference condition approach is intended to accommodate natural variations from climate, bedrock, soils, hydrology, and other natural physiochemical differences, yet it allows differentiation between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology from human activity.

The basis for each water quality target value varies depending on the availability of reference data and sampling method comparability to 2011 EPA data. As discussed in **Appendix B**, there are several statistical approaches DEQ uses for target development. They include using percentiles of reference data or of the entire sample dataset, if reference data are limited. For example, if low values are desired (like with fine sediment), and there is a high degree of confidence in the reference data, the 75th percentile of the reference dataset is typically used.

If reference data are not available, and the sample streams are predominantly degraded, the 25th percentile of the entire sample dataset is typically used. However, percentiles may be used differently depending on whether a high or low value is desirable, how much the representativeness and range of data varies, how severe human disturbance is to streams in the watershed, and the size of the dataset.

In general, stream sediment and habitat conditions within the streams evaluated by EPA in 2011 reflected a minimal to moderate level of human disturbance (i.e., not severely disturbed). For each target, descriptive statistics were generated relative to any available reference data (e.g., KNF or PIBO) as well as for the entire sample dataset. The preferred approach for setting target values is to use reference data, where preference is given to the most protective reference dataset.

Additionally, the target value for some parameters may apply to all streams in the Kootenai-Fisher project area, whereas others may be stratified by bankfull width, reach type characteristics (e.g., ecoregion, gradient, stream order, and/or confinement), or by Rosgen stream type, if those factors are determined to be important drivers for certain target parameters. Although the basis for target values may differ by parameter, the goal is to develop values that incorporate an implicit margin of safety (MOS) and that are achievable. MOS is discussed in additional detail in **Section 5.7**. Field data from the reference site on Granite Creek are not discussed within this section but were compared with target values during the target development process to help evaluate the appropriateness and achievability of target values.

5.4.1 Targets

The sediment water quality targets for the Kootenai-Fisher project area are summarized in **Table 5-2** and described in detail in the sections that follow. Listed in order of preference, sediment-related targets are based on a combination of reference data from the KNF, reference data from the Northern Rockies portion of the PIBO dataset, and sample data from the EPA 2011 sampling effort. For target development purposes, sample dataset percentiles within this section are based on the data collected in the Kootenai-Fisher project area along with data collected by the same methods from 16 reaches in the adjacent Thompson TMDL Project Area (inset, **Figure 5-1**), which is also in the Northern Rockies. Percentiles specific to just the Kootenai-Fisher project area are presented in **Attachment A**. The raw data from the Thompson TMDL Project Area is available by request from DEQ and will be included within the Thompson TMDL document, which will be completed in 2014.

KNF reference data were incorporated (along with other sources) into target development for most of the other Montana sediment TMDLs that have been completed within the Northern Rockies to date: Bobtail Creek (Lindgren and Anderson, 2005), Grave Creek (Montana Department of Environmental Quality et al., 2005), Yaak (Montana Department of Environmental Quality, 2008b), St Regis (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2008), Prospect Creek (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009), Lower Clark Fork (Montana Department of Environmental Quality, 2010), and Tobacco (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011a). Targets from these TMDLs and others that have been completed in Montana within the Northern Rockies (i.e., Flathead Headwaters and Swan) are referenced within this section to provide context for potential target values and/or to apply as target values.

Consistent with EPA guidance for sediment TMDLs (U.S. Environmental Protection Agency, 1999b), water quality targets for the Kootenai-Fisher project area are comprised of a combination of measurements of instream siltation, channel form, biological health, and habitat characteristics that contribute to loading, storage, and transport of sediment, or that demonstrate those effects. Water quality targets most closely linked to sediment accumulation or sediment-related effects to aquatic life habitat are given the most weight (i.e., fine sediment and biological indices). Target parameters and values are based on the current best available information, but they will be assessed during future TMDL reviews for their applicability and may be modified if new information provides a better understanding of reference conditions or if assessment metrics or field protocols are modified. For all water quality targets, future surveys should document stable (if meeting criterion) or improving trends. The exceedance of one or more target values does not necessarily equate to a determination that the information supports impairment; the degree to which one or more targets are exceeded are taken into account (as well as the current 303(d) listing status), and the combination of target analysis, qualitative observations, and sound, scientific professional judgment is crucial when assessing stream condition. Site-specific conditions such as recent wildfires, natural conditions, and flow alterations within a watershed may warrant the selection of unique indicator values that differ slightly from those presented below, or special interpretation of the data relative to the sediment target values.

Table 5-2. Sediment Targets for the Kootenai-Fisher TMDL Project Area

Parameter Type	Target Description	Criterion
Fine Sediment	Percentage of surface fine sediment in riffles via pebble count (reach average)	B & C stream types: 6mm ≤ 15%; 2mm ≤ 8% E stream types: 6mm ≤ 30%; 2mm ≤ 15%
	Percentage of surface fine sediment < 6mm in pool tails and riffles via grid toss (reach average)	B & C stream types: ≤ 9% for pool tails, ≤ 7% for riffles E stream types: ≤ 18% for pool tails, ≤ 14% for riffles
	Percentage of subsurface fine sediment <6.35mm in pool tails via McNeil Core (annual average)	≤ 26%
Channel Form and Stability	Bankfull width/depth ratio (reach median)[1]	B & C stream types with bankfull width < 30ft: ≤ 21 B & C stream types with bankfull width > 30ft: ≤ 32 E stream types: ≤ 8
	Entrenchment ratio[1] (reach median)	B stream types: > 1.4
		C stream types: > 2.7
		E stream types: > 2.3
Instream Habitat	Residual pool depth (reach average)	< 20' bankfull width : ≥ 0.6 (ft)
		20' - 35' bankfull width : ≥ 1.2 (ft)
		> 35' bankfull width : ≥ 1.6 (ft)
	Pools/mile	< 20' bankfull width : ≥ 81
		20' - 35' bankfull width: ≥ 38
		> 35' bankfull width : ≥ 25
		Libby & Lake creeks: : 12-24
	LWD/mile	< 20' bankfull width : ≥ 359
		20' - 35' bankfull width : ≥ 242
		> 35' bankfull width : ≥ 148
Riparian Health	Percent of streambank with understory shrub cover (reach average)	≥ 58% understory shrub cover
Sediment Source	Significant and controllable sediment sources	Identification of significant and controllable anthropogenic sediment sources throughout the watershed
Biological Indices	Macroinvertebrate bioassessment metric	O/E ≥ 0.90 for samples collected since 2011 O/E ≥ 0.80 for samples collected prior to 2011
	Periphyton Increaser Taxa	Probability of Impairment <51%

[1] For other channel types, Rosgen delineative criteria apply (Rosegen 1996)

5.4.1.1 Fine Sediment

The percent of surface fines <6 mm and <2 mm is a measurement of the fine sediment on the surface of a streambed and is directly linked to the support of the coldwater fish and aquatic life beneficial uses. Increasing concentrations of surficial fine sediment can negatively affect salmonid growth and survival, clog spawning redds, and smother fish eggs by limiting oxygen availability (Irving and Bjornn, 1984; Shepard et al., 1984; Suttle et al., 2004; Weaver and Fraley, 1991). Excess fine sediment can also decrease macroinvertebrate abundance and taxa richness (Zweig and Rabeni, 2001; Mebane, 2001).

Because similar concentrations of sediment can cause different degrees of impairment to different species (and even age classes within a species), and because the particle size defined as "fine" is variable (and some assessment methods measure surficial sediment while other measures also include subsurface fine sediment), literature values for harmful fine sediment thresholds are highly variable. Some studies of salmonid and macroinvertebrate survival found an inverse relationship between fine sediment and survival (Suttle et al., 2004) whereas other studies have concluded the most harmful percentage falls within 10% to 40% fine sediment (Relyea et al., 2000; Bjornn and Reiser, 1991; Mebane, 2001). Bryce et al. (2010) evaluated the effect of surficial fine sediment (via reach transect pebble counts) on fish and macroinvertebrates and found that the minimum effect level for sediment <2 mm is 13% for fish and 10% for macroinvertebrates. Literature values are taken into consideration during fine sediment target development; however, because increasing concentrations of fine sediment are known to harm aquatic life, targets are developed using a conservative statistical approach consistent with **Appendix B** and consistent with Montana's water quality standard for sediment as described in **Section 3.2.1**.

Percent Surface Fine Sediment < 6mm and < 2mm in Riffles via Pebble Count

Surface fine sediment measured in riffles by the modified (Wolman, 1954) pebble count indicates the particle size distribution across the channel width and is an indicator of aquatic habitat condition that can point to excessive sediment loading. Pebble counts in 2011 were performed in four riffles per sampling reach for a total of at least 400 particles.

Pebble count reference data are available from the Libby District of the KNF and PIBO. Pebble counts for the Libby District were a composite of riffles and pools, which can increase the fine sediment percentage relative to a riffle-only pebble count; in a review of the field forms, pools did not typically increase the overall percentage of fines, indicating results between the Libby District and Kootenai-Fisher sample dataset are comparable. PIBO data were collected in riffles-only but were not stratified by Rosgen stream type and the sample size is small (n=16). Because the Libby District data are comparable to the DEQ data and the preferable reference dataset, the target for riffle substrate percent fine sediment is based on the 75th percentile of the KNF Libby District reference dataset and is set at less than or equal to 15% < 6mm and 8% < 2mm. PIBO data are not available for <2mm but the 75th percentile for particles <6mm is very close to Libby District value at 16%. The target for sediment < 6mm is the same or similar that set in other TMDL documents within the Northern Rockies (e.g., Lower Clark Fork: 10%, Tobacco/Grave Creek/Prospect Creek: 15%, Yaak/Flathead Headwaters/St. Regis: 20%), and the target for < 2mm is close to the macroinvertebrate minimum effect level of 10% found by Bryce et al. (2010). Rosgen E channels tend to have a higher percentage of fine sediment than B and C channels (which compose all but one of the 2011 EPA assessment reaches), but the KNF Libby District dataset only contains two E channel sites. The 75th percentile values at the KNF reference E channel sites are 1% and 16% for < 6mm and 0% and 8% < 2mm. By comparison, the E channel target value from 115 reference sites in the Beaverhead Deerlodge National Forest (Bengeyfield, 2004) is 30% fine sediment <6mm and there are no data for particles < 2mm.

For B and C channel types, 15% < 6mm and 8% < 2mm will be applied as fine sediment targets for riffle pebble counts. Because the E channel sample size from the Beaverhead Deerlodge National Forest is much greater than from the KNF, a target of 30% <6mm will be applied to E channels in the Kootenai-Fisher project area. Since the fine sediment <2mm target for B and C channels is roughly half of the <6mm target, 15% <2mm will be applied as the target for E channels. The pebble count target values for E channels will carry less weight than for the other channel types because they are based on another ecoregion and have a higher level of uncertainty. Target values should be compared to the reach average value from pebble counts.

Percent Surface Fine Sediment < 6mm in Pool Tails and Riffles via Grid Toss

Grid toss measurements in riffles and pool tails are an alternative measure to pebble counts that assess the level of fine sediment accumulation in macroinvertebrate habitat and potential fish spawning sites. A 49-point grid toss (Kramer et al., 1993) was used to estimate the percent surface fine sediment < 6mm in riffles and pool tails in the Kootenai-Fisher project area, and three tosses, or 147 points, were performed and then averaged for each assessed riffle and for the spawning gravel substrate portion of each assessed pool tail. Riffle grid tosses were performed at the same riffle per cell as pebble counts and pool tail grid tosses were performed at all pool tails with potential spawning gravel (i.e., not all sand or cobble).

For grid toss values, PIBO pool tail data is the only reference data currently available. The 75th percentile of the PIBO reference data for pool tails is 20% and the median is 9%. In the 2011 sample dataset, pool tail grid toss values were low with percentiles as follows: 25th= 4%, median = 7%, and 75th = 10%. The percentiles in the 2011 dataset are likely much lower than PIBO because the DEQ method excludes pool tails where the assessor determines sediment is too fine for spawning. This was done so pools with high levels of fine sediment and no spawning potential would not skew the dataset for a stream that does have pools with suitable spawning habitat and low levels of fine sediment. However, to be more comparable to available reference data, DEQ will be changing its method to match PIBO protocols for pool tail grid toss. This change should be considered during future collection and evaluation of grid toss data in this project area, as a different target value may be necessary.

Reference data sets used for target setting for other TMDLs in the Northern Rockies ecoregion such as St Regis, Grave Creek, Prospect Creek, and Tobacco resulted in pool tail grid toss targets between 8 and 10%. In the absence of reference data, the 75th percentile of the sample data (i.e., 10%) would be considered as a target value. Based on the reference-based target values, and the similarity of the PIBO median to the 75th percentile of the sample dataset, the PIBO median will be used as the basis for the pool tail grid toss target. Therefore, the grid toss target for fine sediment < 6mm in B and C channels is ≤ 9% for pool tails.

In the 2011 sample dataset, riffle grid toss values were less than pool tail values with percentiles as follows: 25th= 1%, median = 3%, and 75th = 7%. The 75th percentile of the sample dataset is less than conservative literature values for harm to aquatic life (i.e., 10%) and similar to the TMDL targets used in the Tobacco and Prospect Creek (i.e., 8 and 10%, respectively), the riffle grid toss target for fine sediment < 6mm in B and C channels is ≤ 7% based on the 75th percentile of the 2011 sample dataset.

A separate target will be applied to E channels because they tend to have a higher percentage of fine sediment than B and C channels. The reference based pebble count target for fine sediment < 6 mm for E channels is double that of B and C channels. That relationship will be used for the grid toss targets for fine sediment < 6 mm; for E channels, the pool grid toss target is ≤ 18% and the riffle grid toss target is ≤ 14%. For each habitat area, the target should be assessed based on the reach average grid toss value.

Percent Subsurface Fine Sediment < 6mm in Pool Tails via McNeil Core

The subsurface substrate in gravel-bottomed rivers tends to be finer than that of the surface layer (Parker and Klingeman, 1982). Because salmonid embryo development takes place in subsurface substrate, the percentage of subsurface fine sediment can be an important indicator of harm to aquatic life. Although the creation of redds by salmonids effectively reduces the amount of fines compared to non-redd substrate (MacDonald et al., 1991; McNeil and Ahnell, 1964), over time, the interstices can refill with fine sediment (Zimmerman and Lapointe, 2005). DEQ not does typically collect subsurface sediment data, however, the Libby District of the Kootenai National Forest routinely collects it from reference and non-reference streams with a McNeil Corer (McNeil and Ahnell, 1964) in areas suitable for spawning. Results presented in this document represent an annual average based on 10 samples.

Based on core samples collected annually from six KNF reference streams since the mid to late 1990s, the 75th percentile is 26% (n=79) (unpublished KNF data). In a study of spawning areas within nine undeveloped watersheds within the Flathead Basin, McNeil core sample particles < 6.35 mm averaged <32% (Weaver and Fraley, 1991). Weaver and Fraley (1991) also looked at fry emergence success by westslope cutthroat and bull trout in response to increasing percentages of fine sediment <6.35 mm and observed a significant inverse relationship between emergence success and the percentage of fine sediment; survival was reduced by about 50 percent for westslope cutthroat when fine sediment approached 27% and for bull trout when fine sediment approached 28%. All of these values are in a similar range as reference based targets used for other TMDLs from the Northern Rockies (i.e., Bobtail Creek/Grave Creek/Prospect Creek/St Regis/Yaak <28% and Flathead Headwaters/Swan <30-35%).

A target value of <26% will be applied based on the 75th percentile of KNF reference data. Since the Kootenai National Forest collects data annually, the target will be applied based on yearly average results from a given stream reach or spawning segment. Particularly since there is such a long term dataset and core values can be variable from year to year, any target exceedances will be evaluated within the context of long-term trending for each stream. The target should only be applied in areas where bull trout or cutthroat trout spawning occurs or has the potential to occur under full support conditions.

5.4.1.2 Channel Form and Stability

Parameters related to channel form indicate a stream's ability to store and transport sediment. Stream gradient and valley confinement are two significant controlling factors that determine stream form and function, however, alterations to the landscape and sediment input beyond naturally occurring amounts can affect channel form. Numerous scientific studies have found trends and common relationships between channel dimensions in properly functioning stream systems and those with a sediment imbalance. Two of those relationships are used as targets in the Kootenai-Fisher project area and are described below.

Width/Depth Ratio and Entrenchment Ratio

The width/depth ratio and the entrenchment ratio provide a measure of channel stability as well as an indication of the ability of a stream to transport and naturally sort sediment into a heterogeneous composition of fish habitat features (e.g., riffles, pools, and near-bank zones).

Changes in both the width/depth ratio and entrenchment ratio can be used as indicators of change in the relative balance between the sediment load and the transport capacity of the stream channel. As the width/depth ratio increases, streams become wider and shallower, suggesting an excess sediment load (MacDonald et al., 1991). As sediment accumulates, the depth of the stream channel decreases, which is compensated for by an increase in channel width when the stream attempts to regain a balance between sediment load and transport capacity.

Conversely, a decrease in the entrenchment ratio signifies a loss of access to the floodplain. Low entrenchment ratios indicate that stream energy is concentrated in-channel during flood events versus having energy dissipate to the floodplain. Accelerated bank erosion and an increased sediment supply often accompany an increase in the width/depth ratio and/or a decrease in the entrenchment ratio (Knighton, 1998; Rosgen, 1996; Rowe et al., 2003). Width/depth and entrenchment ratios were calculated for each 2011 assessment reach based on five riffle cross-section measurements.

Width/Depth Ratio Target Development

There is reference riffle width/ratio data for the KNF, KNF Libby District, and PIBO, but because the Libby District data is a subset of the KNF dataset, only the KNF and PIBO reference data were reviewed as potential targets. The 2011 sample dataset primarily comprises B and C channels, and although on average B channels tend to have a smaller width/depth ratio than C channels (Rosgen, 1996), the ratio can vary quite a bit between small and larger streams. Because the waterbodies in the 2011 Kootenai-Fisher dataset range in bankfull width (BFW) from 5 to 100 feet (median=34 ft, 75th=71 ft), target values are combined for B and C channels and expressed by BFW. Both reference datasets have BFW values that range from approximately 5ft to 60ft, but the PIBO dataset has a much greater number of larger streams (KNF: median=15 ft, 75th=21 ft; PIBO: median=29 ft, 75th=35 ft).

The 75th percentiles of width/depth ratios for both reference datasets (**Table 5-3**) are similar to targets that have been applied in TMDLs for Bobtail Creek, Prospect Creek, the Lower Clark Fork, St Regis, Grave Creek, and the Tobacco. For B and C channels with a bankfull width < 30 ft, the target will be ≤ 21 based on the 75th percentile of the KNF data. For B and C channels with a bankfull width ≥ 30ft, the target will be ≤ 32 based on the 75th percentile of PIBO reference, which has a much greater number of large reference streams than the KNF dataset. The streams in the PIBO dataset are not broken out by Rosgen channel type but based on a review of reference-based width/depth ratio targets ranging from 29-33 for large B/C channels in the St. Regis, Grave Creek, and Prospect Creek TMDLs, 32 is an appropriate target for larger B/C channels within the Kootenai-Fisher project area. Raven Creek downstream of Highway 2 was the only stream segment identified as a different channel type (i.e., E), and although the sample size is smaller than desired, the target for E channels will be ≤ 8 based on the 75th percentile of E channel in the KNF dataset (**Table 5-3**) because the PIBO dataset is not broken out by stream type.

Table 5-3. The 75th Percentiles of Reference Data used for Width/Depth Ratio Target Development

Data Source	Category	Sample Size	75th Percentile W/D
KNF Reference	B/C channels BFW < 30’	94	**21**
KNF Reference	B/C channels BFW > 30’	7	29
KNF Reference	E channels	3	**8**
PIBO Reference	BFW < 30’	61	26
PIBO Reference	BFW > 30’	48	**32**

Entrenchment Ratio Target Development

Because higher values are more desirable for entrenchment ratio, the target value for entrenchment ratio is set at greater than or equal to the 25th percentile of the KNF reference data (**Table 5-4**). When comparing assessment results to target values, more weight will be given to those values that fail to satisfy the identified target and fail to meet the minimum value associated with literature values for Rosgen stream type (i.e., B=1.4-2.2 ± 0.2, C & E 2.2 ± 0.2) (Rosgen, 1996) and reaches with multiple potential channel types will be evaluated using the lowest target value (e.g., Target for B3/C3 = 1.4).

Table 5-4. Entrenchment Targets for the Kootenai-Fisher TMDL Project Area Based on the 25th Percentile of KNF Reference Data

Rosgen Stream Type	Sample Size	25th Percentile of KNF Reference Data
B	93	1.4
C	8	2.7
E	3	2.3

Channel form targets are expressed specifically for B, C, and E channels because they are either the primary existing or potential channel type in low gradient sections of the streams of concern, which is where the effects of excess sediment from human sources are most likely to be observed. For channel types not specifically mentioned above (i.e., A, F, D, G), the Rosgen delineative criteria for width/depth ratio and entrenchment apply (Rosgen, 1996). Channel types can evolve naturally or as a result of human changes to the landscape, and channel type adjustments should be evaluated in the context of the potential cause(s) and whether human sources are causing channel instability or if the channel is recovering.

5.4.1.3 Instream Habitat Measures

For all instream habitat measures (i.e., residual pool depth, pool frequency, and large woody debris frequency), there is available reference data from the Libby District of the KNF and from PIBO. All of the instream habitat measures are important indicators of sediment input and movement as well as fish and aquatic life support, but they may be given less weight in the target evaluation if they do not seem to be directly related to sediment impacts. The use of instream habitat measures in evaluating or characterizing impairment needs to be considered from the perspective of whether these measures are linked to fine, coarse, or total sediment loading.

Residual Pool Depth

Residual pool depth, defined as the difference between the maximum depth and the tail crest depth, is a discharge-independent measure of pool depth and an indicator of the quality of pool habitat. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes and high flow periods (Bonneau, 1998; Nielson et al., 1994; Baigun, 2003). Similar to channel morphology measurements, residual pool depth integrates the effects of several stressors; pool depth can be decreased as a result of filling with excess sediment (fine or coarse), a reduction in-channel obstructions (such as large woody debris), and changes in-channel form and stability (Bauer and Ralph, 1999). A reduction in pool depth from channel aggradation may not only alter surface flow during the critical low flow periods, but may also impair fish condition by altering habitat, food availability, and productivity (Sullivan and Watzin, 2010; May and Lee, 2004). Residual pool depth is typically greater in larger systems.

Although the residual pool depth measure is similar between DEQ’s method and both reference methods, the definition of a pool can vary between the methods. Out of both available reference datasets, the core definition of pools for the PIBO protocol is closer to the definition used for the DEQ 2011 sample dataset where pools were defined as depressions in the streambed bounded by a “head crest” at the upstream end and “tail crest” at the downstream end with a maximum depth that is at least 1.5 times the pool tail depth (Kershner et al., 2004). The Libby District dataset defines pools as slack water areas occupying at least one-third of the bankfull channel with a scour feature and hydraulic control.

DEQ further defined pools as large or small depending on the width of the pool in relation to the stream's bankfull width, whereas the PIBO protocol only counts pools greater than half the wetted channel width. In comparison to the PIBO dataset, the 2011 sample dataset could have a higher pool frequency and more pools with a smaller residual pool depth since the DEQ protocol has no minimum pool width requirement. In comparison to the Libby dataset, the 2011 sample dataset could have a lower pool frequency but more pools with a deeper residual pool depth since some slack water areas in the Libby District dataset might not meet the head crest to tail crest ratio requirement used by DEQ. However, residual pool depths in the sample dataset are not noticeably less than the PIBO depths or greater than the Libby depths, indicating the slight protocol differences are not an issue and the reference datasets are appropriate to use for setting residual pool depth targets.

The 25th percentile of the Libby reference data will be applied as residual pool depth targets for streams with a bankfull width < 35ft (**bolded** in **Table 5-5**), which is the upper limit of streams in the Libby dataset. During the field effort in 2011, the maximum depth in several pools was estimated because they were too deep to safely wade, which is supported by the 25th percentile and median of the sample dataset being greater than PIBO reference. Therefore, the residual pool depth target for streams with a bankfull width ≥35 will be 1.6 ft based on the PIBO median (**bolded** in **Table 5-5**). Although none of the channels in the PIBO reference dataset are as wide as the reaches assessed on Lake and Libby creeks, 1.6 ft should be a reasonable target based on existing conditions within the project area and because residual pool depth tends to increase with channel size. The same value was applied for larger streams in the Tobacco watershed (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011a), and values between 1.6 and 1.9 ft were applied to large streams in the Lower Clark Fork TMDLs (Montana Department of Environmental Quality, 2010).

The target values should be assessed based on the reach average residual pool depth value. Because residual pool depths can indicate if excess sediment is limiting pool habitat, this parameter will be particularly valuable for future trend analysis using the data collected in 2011 as a baseline. Future monitoring should document an improving trend (i.e., deeper pools) at sites which fail to meet the target criteria, while a stable trend should be documented at established monitoring sites that are currently meeting the target criteria.

Table 5-5. Percentiles of Reference Data and 2011 Sample Data for Residual Pool Depth (ft)

Category	Libby Reference			PIBO Reference			2011 Sample Data			
	n	Median	25th	n	Median	25th	n	Median	25th	75th
< 20' BFW	57	0.8	**0.6**	33	0.9	0.7	137	0.8	0.6	1.0
20-35' BFW	18	1.4	**1.2**	46	1.1	0.9	107	1.1	0.8	1.7
> 35' BFW	0	--	--	29	**1.6**	1.1	60	1.9	1.3	3.0

Targets are shown in **bold**.

Pool Frequency

Pool frequency is another indicator of sediment loading that relates to changes in channel geometry and is an important component of a stream's ability to support the fishery beneficial use for many of the same reasons associated with the residual pool depth discussed above and also because it can be a major driver of fish density (Muhlfeld and Bennett, 2001; Muhlfeld et al., 2001). Sediment may limit pool habitat by filling in pools with fines. Alternatively, aggradation of larger particles may exceed the stream's capacity to scour pools, thereby reducing the prevalence of this critical habitat feature. Pool frequency generally decreases as stream size (i.e., watershed area) increases.

Similarly to the residual pool depth values, protocol differences did not result in noticeable differences in the pool frequency, indicating the Libby and PIBO reference datasets are suitable for setting targets. Therefore, the 25th percentile of the Libby reference data will be applied as pool frequency targets for streams with a bankfull width < 35ft (**bolded** in **Table 5-6**), which is the upper limit of streams in the Libby dataset. Since the PIBO 25th percentile is comparable to all quartiles from the sample dataset, 25 pools per mile will be applied as the pool frequency target for streams with a bankfull width ≥ 35 ft (**Table 5-6).** The pool frequency targets are similar to the Inland Native Fish Strategy (INFISH) Riparian Management Objectives (U.S. Department of Agriculture, Forest Service, 1995) as well as reference data from the Swan River and Grave Creek watersheds (Montana Department of Environmental Quality et al., 2005) (**Table 5-7**).

Because pool frequency tends to decline as stream size increases and the PIBO dataset only includes streams with a bankfull width up to 50 feet, 25 pools per mile may be too high of a target for Lake and Libby creeks, which ranged in average bankfull width from 68-87 ft. The TMDL target for the C channel reaches of lower Grave Creek (Montana Department of Environmental Quality et al., 2005) is 12-24 pools/mile based on an internal reference reach and will be applied as the target for the Libby and Lake creeks. The INFISH goal for streams with a bankfull width of 75 ft is 23 pools per mile (**Table 5-7**), and one reach on Libby Creek exceeded this value, indicating a value near the upper end of the target range is achievable and preferable. Pools per mile should be calculated based the number of measured pools per reach and then scaled up to give a frequency per mile.

Table 5-6. Percentiles of Reference Data and 2011 Sample Data for Pool Frequency (pools/mile)

Category	Libby Reference			PIBO Reference			2011 Sample Data			
	n	Median	25th	n	Median	25th	n	Median	25th	75th
< 20’ BFW	57	114	**81**	33	82	44	12	84	67	121
20-35’ BFW	18	53	**38**	46	38	32	7	63	53	98
>35’ BFW	0	--	--	29	34	**25**	10	26	26	28
Libby & Lake Creeks	Target value = **12 -24** pools/mile based on Grave Creek reference, PIBO, and INFISH									

Targets are shown in **bold**

Table 5-7. INFISH and Reference Pool Frequency Values by Channel Bankfull Width (BFW)

Comparative Data Source	Smaller Stream Values (pools/mile)	Larger Stream Values (pools/mile)
Swan River tributary reference	19-35’ BFW: 25th = 70	35-45’ BFW: 25th = 29
Grave Creek reference	10-20’ BFW: 73-118 20-35’ BFW: 47-66	40-60’ BFW: 12-24
INFISH	< 20’ BFW: 56-96 25’ BFW: 47	50’ BFW: 26 75’ BFW: 23

Large Woody Debris

Large woody debris (LWD) is a critical component of stream ecosystems, providing habitat complexity, quality pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989). LWD numbers generally are greater in smaller, low order streams. The application of a LWD target will carry very little weight for sediment impairment verification purposes, but may have significant implications as an indicator of a non-pollutant type of impairment.

For EPA sampling in 2011, wood was counted as LWD if it was greater than 9 feet long or two-thirds of the wetted stream width, and 4 inches in diameter at the small end (Overton et al., 1997). The LWD count for both available reference datasets was compiled using a different definition of LWD than the 2011 sample dataset; if measurements were conducted within the same reach, the Libby District LWD count would likely be less than the 2011 LWD count because the protocol only counted wood if it was larger than 6 inches in diameter and longer than the BFW, and the PIBO LWD count would likely be greater because it includes pieces 3 feet long and 4 inches in diameter. Unlike for pool frequency and residual pool depth, the summary statistics indicate the protocol differences did result in lower numbers in the Libby dataset and greater numbers in the PIBO dataset (except for BFW < 20 ft) (**Table 5-8**).

The Libby dataset is the preferred reference dataset for setting target values; however, using the 25th percentile of the Libby dataset as a starting point, it is less than the 25th percentile of the sample dataset, indicating the effect of the protocol difference and that the potential for streams of concern in the project area is greater than the 25th percentile of the Libby dataset. Therefore, LWD target values for streams with a bankfull width <35 ft will be based on the median of the Libby reference data (**bolded** in **Table 5-8**). For streams with a BFW ≥ 35 feet, both the PIBO median and 25th percentile values are too high relative to the sample data and are not appropriate targets. Therefore, the 25th percentile of the sample data, 148 pieces of LWD per mile, will be applied as the target for all streams with a BFW ≥ 35 feet. A range of 104-210 LWD per mile was applied as a target in TMDLs for Grave Creek, Prospect Creek, St Regis, and Tobacco based on the 25th and 75th percentile of reference data from the Swan River watershed for streams with a bankfull width ≥ 35 ft (Land & Water Consulting, Inc. et al., 2004). This range indicates the 25th percentile of the sample data is an appropriate target. Due to the extent of historical timber removal or channel encroachment by the transportation network, it is acknowledged that these targets may not be achievable for all streams.

Table 5-8. Percentiles of Reference Data and 2011 Sample Data for LWD (LWD/mile)

Category	Libby Reference			PIBO Reference			2011 Sample Data			
	n	Median	25th	n	Median	25th	n	Median	25th	75th
< 20’ BFW	57	**359**	183	33	244	90	12	359	206	638
20-35’ BFW	18	**242**	92	46	412	243	7	285	177	330
> 35’ BFW	0	--	--	29	466	298	10	321	**148**	396

Targets are shown in **bold**. Note, the minimum LWD size varies by dataset: Libby is 6 inch diameter and longer than bankfull width; PIBO is 4 inch diameter and 3 feet long; and DEQ is 4 inch diameter and 9 feet long or greater than 2/3 channel wetted width.

5.4.1.4 Riparian Health

Riparian Understory Shrub Cover

Interactions between the stream channel and the riparian vegetation along the streambanks are a vital component in the support of the beneficial uses of coldwater fish and aquatic life. Riparian vegetation provides organic material used as food by aquatic organisms and supplies LWD that influences sediment storage and channel morphology. Riparian vegetation helps filter sediment from upland runoff, stabilize streambanks, and it can provide shading, cover, and habitat for fish. During EPA assessments conducted in 2011, ground cover, understory shrub cover and overstory vegetation were cataloged at 10 to 20 foot intervals along the greenline at the bankfull channel margin along both sides of the stream channel for each monitoring reach. The percent of understory shrub cover is of particular interest in valley bottom streams historically dominated by willows and other riparian shrubs. While shrub cover is important for stream health, not all reaches have the potential for dense shrub cover and are instead well armored with rock or have the potential for a dense riparian community of a different composition, such as wetland vegetation or mature pine forest.

There is no available understory shrub cover reference data so the target is based on the sample dataset. At the 2011 assessment sites, there was an average value of 59% understory shrub cover and a median value of 58% understory shrub cover. Based on this median value, a target value of ≥ 58% is established for understory shrub cover in the Kootenai-Fisher project area. This target value should be assessed based on the reach average greenline understory shrub cover value. Because not all reaches have the potential for dense shrub cover, for any reaches that do not meet the target value, the greenline assessment results will be more closely examined to evaluate the potential for dense riparian shrub cover and identify if the streambanks in the reach are stabilized instead by rocks, a mature pine forest, and/or wetland vegetation.

5.4.1.5 Sediment Supply and Sources

Anthropogenic Sediment Sources

The presence of anthropogenic sediment sources does not always result in sediment impairment of a beneficial use. When there are no significant identified anthropogenic sources of sediment within the watershed of a 303(d) listed steam, no TMDL will be prepared since Montana's narrative criteria for sediment cannot be exceeded in the absence of human causes. There are no specific target values associated with sediment sources, but the overall extent of human sources will be used to supplement any characterization of impairment conditions. This includes evaluation of human induced and natural sediment sources, along with field observations and watershed scale source assessment information obtained using aerial imagery and Geographic Information System (GIS) data layers. Because sediment transport through a system can take years or decades, and because channel form and stability can influence sediment transport and deposition, any evaluation of anthropogenic sediment impacts must consider both historical sediment loading as well as historical impacts to channel form and stability since the historical impacts still have the potential to contribute toward sediment and/or habitat impairment. Source assessment analysis will be provided by 303(d) listed waterbody in **Section 5.5**, with additional information in **Attachment A** and **Appendices C** and **D.**

5.4.1.6 Biological Indices

Macroinvertebrates

Siltation exerts a direct influence on benthic macroinvertebrates assemblages by filling in spaces between gravel and by limiting attachment sites. Macroinvertebrate assemblages respond predictably to siltation with a shift in natural or expected taxa to a prevalence of sediment tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessment scores are an assessment of the macroinvertebrate assemblage at a site, and DEQ uses one bioassessment method to evaluate stream condition and aquatic life beneficial-use support. Aquatic insect assemblages may be altered as a result of different stressors such as nutrients, metals, flow, and temperature, and the biological index values must be considered along with other parameters that are more closely linked to sediment.

The macroinvertebrate assessment tool used by DEQ is the Observed/Expected model (O/E). The rationale and methodology for the index is presented in the Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2006). The O/E model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled and is expressed as a ratio of the

Observed/Expected taxa (O/E value). The O/E community shift point for western Montana streams is any O/E value < 0.90. Therefore, an O/E score of ≥ 0.90 is established as a sediment target in the Thompson Project Area. Note, the threshold for data collected prior to 2011 is 0.80 because the O/E model has been updated since that time to better reflect DEQ's current sampling protocol (i.e., MAC-R-500). The rationale and methodology for the previous O/E model and 0.80 threshold value is detailed in the previous macroinvertebrate standard operating procedure (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2006).

Unless noted otherwise, macroinvertebrate samples discussed within this document were collected according to DEQ protocols. USFS samples were collected by the KNF in both riffles and pools with either a Hess or Surber sampler. A large proportion of the USFS data had O/E scores well below 0.80, which caused DEQ to examine the data more closely. The O/E model is very sensitive to the macroinvertebrate collection method, and DEQ determined that it is not appropriate to use the O/E model to evaluate macroinvertebrate health within the Kootenai-Fisher project area using USFS samples collected by the Hess or Surber method. Instead, the taxonomic composition of each sample was evaluated and a narrative summary was added to the DEQ assessment file for each applicable stream (i.e., Bristow, Libby (above Hwy 2), Quartz, and Wolf). That summary information is discussed within this document as part of the data evaluation for each applicable stream.

An index score greater than the threshold value is desirable, and the result of each sampling event is evaluated separately. Because index scores may be affected by other pollutants or forms of pollution such as habitat disturbance, they will be evaluated in consideration of more direct indicators of excess sediment. Additionally, because the macroinvertebrate sample frequency and spatial coverage is typically low for each watershed and because of the extent of research showing the harm of excess sediment to aquatic life, meeting the macroinvertebrate target does not necessarily indicate a waterbody is fully supporting its aquatic life beneficial use and measures that indicate an imbalance in sediment supply and/or transport capacity will also be used for TMDL development determinations.

Periphyton

Periphyton are algae that live attached to or in close proximity to the stream bottom. Algae are ubiquitous in Montana surface waters, easy to collect, and represented by large numbers of species. Measures of the structure of algal associations, such as species diversity and dominance, can be useful indicators of water quality impacts and ecological disturbance.

DEQ collected periphyton from reference streams and from streams known to have excess sediment and used statistical analysis to identify taxa that tend to increase in the presence of excess sediment (Teply, 2010b; Teply, 2010a). Algal community composition and dynamics differs geographically, and DEQ has developed ecoregion-specific periphyton sediment metrics. The rationale and methodology for the periphyton-based metrics is presented in the DEQ Periphyton Standard Operating Procedure (Montana Department of Environmental Quality, 2011b). The metric is reported as a percent probability of impairment. According to the DEQ Standard Operating Procedure (Montana Department of Environmental Quality, 2011b) a probability of impairment > 51% indicates sediment may be impairing aquatic life but should be used in conjunction with other data when assessing stream condition. Therefore, > 51% probability of impairment will be applied as a target for the Kootenai-Fisher project area, and it will be interpreted in the context of other indicators of sediment impairment for each stream.

5.4.2 Existing Conditions and Comparison to Targets

This section includes a comparison of existing data with water quality targets, along with a TMDL development determination for each stream segment of concern in the Kootenai-Fisher project area (**Section 5.2**). The TMDL development determination is whether or not recent data supports the impairment listing and whether a TMDL will or will not be completed, but it is not a formal impairment assessment. All waterbodies reviewed in this section are listed for sediment impairment on the 2012 303(d) List. Although inclusion on the 303(d) list indicates impaired water quality, a comparison of water quality targets with existing data helps define the level of impairment and establishes a benchmark to help evaluate the effectiveness of restoration efforts.

5.4.2.1 Bristow Creek (MT76D002_110)

Bristow Creek (MT76D002_110) is listed for sedimentation/siltation on the 2012 303(d) List. It was originally listed in 1992 because of excess sediment associated with timber harvest and roads. Both in the early and mid-1990s rain-on-snow events caused extensive damage to the road network and accelerated erosion, particularly in the upper watershed. In 2004, the KNF requested delisting of Bristow Creek for sediment based on improved channel stability, a low percentage of fine sediment, and the removal of 12 stream crossings. At that time, DEQ determined that the stream was recovering from historic management but still affected by siltation. Bristow Creek flows 6.4 miles from its headwaters to its mouth at Lake Koocanusa.

Physical Condition and Sediment Sources

The DEQ assessment file states that a 2002 photo from KNF monitoring site showed dense riparian vegetation, lots of LWD, a heavy cobble bedload, and stable streambanks. Additionally, pool frequency was noted to be low and it was observed that excess fine sediment was likely still moving through the system. An Environmental Assessment (EA) was completed for the Bristow Area Restoration Project (U.S. Department of Agriculture, Forest Service, 2003) which proposed timber thinning, road improvements and decommissioning, and stream habitat improvement projects. One of the goals was to make roads within the drainage hydrologically neutral (i.e., not altering natural runoff and streamflow patterns). Within the EA, the large amount of timber harvest on both private and public land was noted as well as road encroachment and undersized culverts in the lower watershed. Additionally, it was noted that macroinvertebrate samples indicated a decline in water quality between 1996 and 2002. Bristow Creek was determined to be functioning at risk. Most recently, DEQ analyzed the taxonomic composition of seven macroinvertebrate samples collected by the KNF between 2003 and 2010 at a site two miles upstream of the mouth (**Figure 5-1)** (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013). Taxa that are sensitive to water quality changes were found in all samples, but up until 2006, taxa tolerant of water quality changes were most prevalent. However, starting in 2009, the macroinvertebrate community composition shifted and samples were dominated by a stonefly very sensitive to water quality changes, indicating very good water quality.

In 2011, EPA collected sediment and habitat data at two sites on Bristow Creek (**Figure 5-1**). The upper site, BRST04-02, was located along a forested reach of Bristow Creek that did not appear to have been logged in recent history, though evidence of recent selective harvesting was observed upstream of the monitoring site and along the stream channel corridor downstream of the monitoring site. Ferns covered the forest floor and large conifers in the overstory limited the amount of understory shrub cover in this reach. Channel conditions were typical of a lower gradient mountain stream with LWD aggregates forming pools and relatively large substrate limiting potential spawning sites. Streambanks were composed of coarse material and the small amount of bank erosion observed was attributed to natural sources. The lower site, BRST04-04, was located along a forested reach of Bristow Creek downstream of the Koocanusa West Side road crossing. Similar to the upper site, the riparian corridor did not appear to have been logged in recent history, but evidence of more recent selective harvest was observed upstream of the monitoring site. Ferns covered the forest floor and large conifers in the overstory limited the amount of understory shrub cover in this reach, though some alders were present along the channel margin at the upstream end of the reach. Channel conditions were typical of a cobble and boulder dominated step-pool mountain stream with frequent small pools and large substrate that limited pool depth and spawning habitat. The streambanks were comprised of coarse material and the minor amount of streambank erosion was attributed to natural sources. Both sites were determined to be meeting their potential.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for Bristow Creek are summarized in **Tables 5-9** and **5-10**. The macroinvertebrate bioassessment data are located in **Table 5-11**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-9. Existing sediment-related data for Bristow Creek relative to targets

Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
BRST04-02	2011	23.1	B3	B3	8	7	3	2	18.6	2.9	**0.8**	121	375
BRST04-04	2011	21.5	B3	B3	3	2	1	**10**	15.1	2.2	**0.9**	153	343

Table 5-10. McNeil Core Results for Bristow Creek

Values that exceed the target (26%) are in bold.

Year	2003	2004	2005	2006	2007	2008	2009	2010
Ave % <6.35mm	7	20	7	20	18	24	23	16

Table 5-11. Bioassessment data for Bristow Creek

Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
BRST04-02	9/8/2011	DEQ – EMAP	**0.85**	20
BRST04-04	9/8/2011	DEQ - EMAP	**0.83**	24

Summary and TMDL Development Determination

For fine sediment, the riffle pebble count and McNeil core results met the target value. All grid toss values met the target except for pools at the lower site, which were just over the target value of 9%. The channel morphology parameters also met the target values. Residual pool depths at both sites did not meet the target value, but given the large cobbles that dominate the system and predominance of step-pools, the pool depths are likely at their potential. For the biological parameters, the periphyton samples met the target but both macroinvertebrate samples were below the O/E target. Because the

KNF samples from the past five years indicate a healthy and stable macroinvertebrate community (discussed above), the periphyton samples met the target, and the McNeil core samples met the target, the O/E scores do not appear to be associated with harm from sediment.

Roads were originally identified as a substantial sediment source, and the Kootenai National Forest has made extensive road and culvert improvements since that time (discussed above). An assessment of unpaved roads was conducted for sediment TMDL support and five crossings were visited within the Bristow Creek watershed (**Appendix D**). Two of the crossings could not be accessed because the road had been closed and decommissioned, and the other three crossings had limited erosion because of water bars. It is important that the KNF continue to adequately maintain and evaluate the effectiveness of BMPs at road crossings, but field observations indicate that efforts to mitigate road-related sediment inputs have been successful. Accelerated sediment loading associated with historical rain-on-snow events also underscores the importance of continued implementation of best management practices during timber harvest and other ground-disturbing activities. Based on current land management practices that are mitigating human sources of sediment and the comparison of recent instream data to the targets, Bristow Creek is no longer impaired for sediment and a TMDL will not be written. The 303(d) listing status will be formally reevaluated by DEQ in the future.

5.4.2.2 Lake Creek (MT76D002_070)

Lake Creek (MT76D002_070) is listed for sedimentation/siltation on the 2012 303(d) List. It was originally listed in 1992 because of excess sediment associated with timber harvest, roads, grazing, mining, and residential development. Lake Creek flows 17.6 miles from its headwaters at the outlet of Bull Lake to its mouth at the Kootenai River. One-quarter mile upstream of the mouth in a canyon section with a waterfall, a hydroelectric dam was built in 1917 that is still in operation. The Lake Creek Dam is a barrier to upstream fish movement but has minimal storage capacity and minimally affects flows or the channel upstream of it (USDA Forest Service, Kootenai National Forest (KNF), 2010).

Physical Condition and Sediment Sources

As part of the Upper Kootenai Subbasin Review (U.S. Department of Agriculture, Forest Service, 2002) and the Sparring Bulls Environmental Impact Statement (USDA Forest Service, Kootenai National Forest (KNF), 2010; USDA Forest Service, Kootenai National Forest (KNF), 2012), the KNF has summarized historical sources of sediment loading, BMPs implemented, and current sediment sources along Lake Creek and its tributary watersheds. The road crossing density and equivalent clearcut area is generally low; however, roads built on sensitive land types or with undersized drainage structures were prone to road failures (U.S. Department of Agriculture, Forest Service, 2002; USDA Forest Service, 2009b). Starting in the 1960s, road development for mining, and timber harvest in the Ross Creek subwatershed caused multiple slope failures but most of the sediment is believed to have been retained in Bull Lake (U.S. Department of Agriculture, Forest Service, 2002). Other streams in the upper watershed that are believed to be more direct sediment sources are Camp and Stanley creeks because of road failure, timber harvest, and mine operations (Stanley only) (USDA Forest Service, Kootenai National Forest (KNF) and Montana Department of Environmental Quality, 2011). Lower in the watershed, Iron and Keeler creeks have altered riparian vegetation and channel stability issues (Marotz et al., 1988; USDA Forest Service, 2009a). In particular, Keeler Creek has had major problems with sediment loading from road failure, and aerial photos indicate it has contributed substantial amounts of sediment to Lake Creek since the harvest and road development activities began in the late 1940s (USDA Forest Service, 2009a). For instance, in during 1974 and 1980 flood events, there were forty document road failures (USDA Forest Service, 2009a). Although road related inputs have generally declined since the 1990s, road problems are continuing to add excess sediment to Keeler Creek, as well as other Lake Creek tributaries

(USDA Forest Service, 2009b). As a result of the 2001 Spar and Lake Subunits Forest Health Project Record of Decision, BMPs including removal of 19 crossings and decommissioning, stabilization, and improvement were applied to over 30 miles of USFS roads in the Keeler watershed between 2003 and 2008 (USDA Forest Service, 2009b; USDA Forest Service, Kootenai National Forest (KNF), 2012). Numerous road improvements were proposed in the 2009 Sparring Bulls Environmental Impact Statement (USDA Forest Service, Kootenai National Forest (KNF), 2012). Most of the BMP work for Sparring Bulls has been accomplished, but none of the road storage or decommissioning work has yet been implemented. The storage and decommissioning work is proposed in Madge (tributary to Camp) and Keeler watersheds. The work in Keeler cannot occur until all timber sale activities are completed, and the work in Madge can occur as soon as funding is secured (Newgard, Kris, personal communication 3/20/2014).

Although most of the Lake Creek watershed is managed by the USFS (~80%), the entire riparian corridor is privately owned (**Appendix A**, **Figure A-15**). The private land was historically predominantly owned by timber companies, who selectively harvested riparian vegetation, but those holdings have increasingly been divested and the land is being developed for residential and recreational uses (U.S. Department of Agriculture, Forest Service, 2002; USDA Forest Service, Kootenai National Forest (KNF), 2010). For instance, approximately 4,000 acres of Plum Creek land (mostly along Lake Creek) were sold off to individuals and developers between 2001 and 2004, and home development is ongoing on that acreage (USDA Forest Service, Kootenai National Forest (KNF), 2010). Surveys by the KNF identified moderate levels of fine sediment and a limited amount of high quality spawning habitat where gravel substrate exists (USDA Forest Service, 2009b). To help preserve the riparian corridor and upland habitat within a large portion of the remaining private timber holdings, Stimson Lumber Company sold 28,000 acres in the Kootenai valley as a conservation easement to FWP in December 2012 (Scott, 12/20/2012); this includes approximately 8,200 acres in the Lake Creek watershed (**Figure 5-2**).

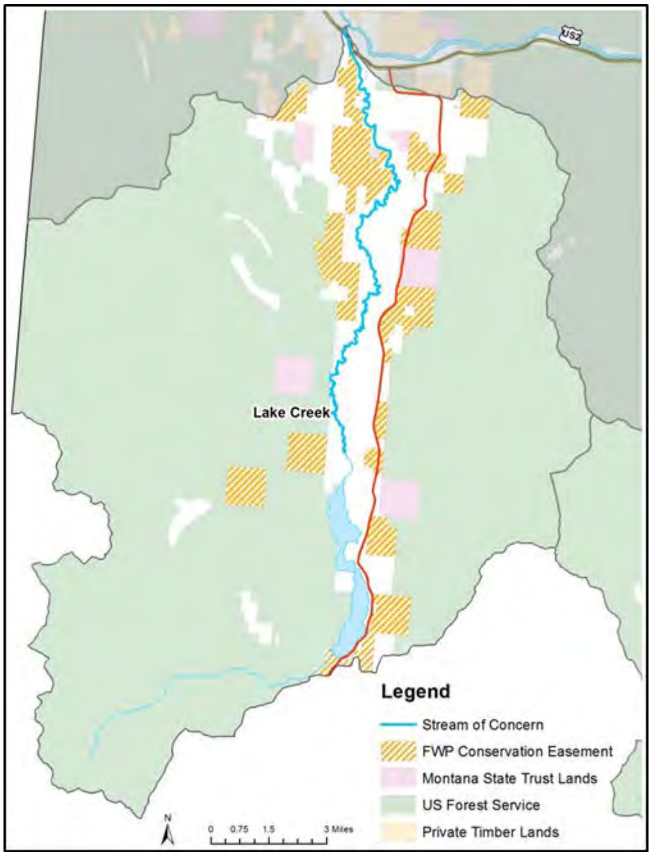

Figure 5-2. Ownership in Lake Creek watershed showing FWP conservation easement

Increasing development on private land has affected Lake Creek by the removal of riparian trees and LWD, and the placement of riprap on streambanks (USDA Forest Service, 2009a). The streambanks are fine-grained glacial till, glacial outwash, and lacustrine material that is highly erodible if not well vegetated, particularly by perennial plants and trees (U.S. Department of Agriculture, Forest Service, 2002; USDA Forest Service, Kootenai National Forest (KNF), 2010). Erosion of the fine-grained streambanks is a chronic source of sediment at high flows (Dunnigan, Jim, personal communication 10/18/2013). Even at lower flows, fine sediment can sometimes be observed in suspension for several miles (Hensler, Mike, personal communication 10/28/2013). Elevated levels of suspended sediment, particularly for an extended period of time, can harm aquatic life in a variety of ways ranging from behavioral changes and a reduction in feeding ability and reproductive success to death (Newcombe and Jensen, 1996; Suttle et al., 2004; Berry et al., 2003).

Streambank erosion that has been accelerated as a result of residential development and removal of riparian vegetation was observed at one of the 2011 monitoring sites (**Figure 5-3**, photo right, and discussed below), and also occurs between the two 2011 monitoring sites (**Figure 5-3**, photo left (courtesy of K. Newgard) (Newgard, Kris, personal communication 3/20/2014). The erosion occurring between the 2011 monitoring sites is a large unstable streambank that has been actively retreating since the early 1990s, and has progressed to become a site of mass wasting that extends several hundred feet up the hillslope (Hensler, Mike, personal communication 3/17/2014). This particular streambank is one of the sources that has caused elevated levels of suspended sediment for weeks (Newgard, Kris, personal communication 3/20/2014).

Figure 5-3. Actively eroding streambanks on Lake Creek that have worsened by removal of riparian vegetation and development. Left photo courtesy of K. Newgard, Kootenai National Forest, 2009.

In 2011, EPA collected sediment and habitat data at two sites on Lake Creek (**Figure 5-1**). The upper site, LAKE02-01, was located in an area of limited rural residential development along Lake Creek. This reach contained one very deep pool formed by large woody debris at a meander bend. The channel transitioned from a meandering channel to more of a riffle dominated channel progressing upstream through the monitoring site. Naturally eroding streambanks occurred at the outsides of meander bends, with alders along the channel margin and conifers on the floodplain. The lower site, LAKE03-03, was located upstream of the Lake Creek/Spar Lake road crossing. The road was very close to the left streambank at the downstream end of the reach and the streambank was lined with riprap. Immediately upstream of the riprap, this streambank has not been stabilized and is actively eroding. The erosion is threatening a structure on the property, and the landowner estimated the streambank has retreated 10 feet over the past 7 years. The opposite streambank progressing upstream is also riprapped along a field, likely leading to the accelerated rate of erosion at the next meander bend downstream. Lake Creek is a meandering channel with a well defined riffle-pool sequence and gravel bars at the insides of meander bends. Fine sediment was observed in the interstitial spaces of the coarse gravel substrate. This reach contained several very deep pools, which were estimated at 8-10 feet deep. These pools were typically formed by LWD accumulating at meander bends. Riparian vegetation removal for agricultural activities has occurred and the channel margin was noted to generally lack overstory vegetation at the downstream end of the reach. Progressing upstream, conifer forests occur at the outside of meander bends, with cottonwood galleries at the inside of meander bends.

Comparison with Water Quality Targets

The existing data in comparison with the targets for Lake Creek are summarized in **Table 5-12**. The macroinvertebrate bioassessment data are located in **Table 5-13**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-12. Existing sediment-related data for Lake Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
LAKE02-01	2011	67.8	C3/C4	C4	8	4	3	0	28.6	**2.5**	3.9	16	396
LAKE03-03	2011	99.5	C4	C4	5	5	6	**11**	24.3	5.6	7.0	13	396

Table 5-13. Macroinvertebrate bioassessment data for Lake Creek
Values that do not meet the target threshold (0.90 for O/E and <51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
LAKE02-01	9/7/2011	DEQ – EMAP	**0.83**	17
LAKE03-03	9/7/2011	DEQ - EMAP	**0.85**	18

Summary and TMDL Development Determination
All measures of fine sediment in riffles met the target value, but the pool tail grid toss value slightly exceeded the target at the lower site. Overall, the channel morphology is stable; width/depth ratios were within the expected range and met the target at both sites, and the upper site fell slightly short of the entrenchment ratio target but still met the Rosgen criteria. Pool quality was very high at the assessment sites with pool frequency being within the expected range and residual pool depths easily meeting the target. LWD, which was the most abundant form of cover for pools, also easily met the target value at both sites. The periphyton samples from both sites met the target value, but both macroinvertebrate samples did not meet the target. The failure of the grid toss and macroinvertebrate targets, combined with the eroding streambanks that are causing extended periods of elevated turbidity indicate sediment is likely limiting its ability to fully support aquatic life. This information as well as the sensitivity of upland soils and streambanks, increasing level of development and pressure on the riparian zone along Lake Creek, and remaining road issues in tributary watersheds supports the current listing and a sediment TMDL will be developed for Lake Creek. However, because fine sediment was only slightly above the target for one metric, the extent of road mitigation work that has occurred, and the substantial amount of riparian acreage that was recently placed into a conservation easement, additional data regarding remaining human sediment sources and instream conditions should be collected prior to TMDL implementation to determine if additional restoration measures are necessary.

5.4.2.3 Libby Creek, lower segment (MT76D002_062)

The lower segment of Libby Creek (MT76D002_062) is listed for sedimentation/siltation on the 2012 303(d) List. In addition, this segment is also listed for physical substrate alterations, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1996 because of aggradation, streambank erosion, and instability attributed to removal of riparian vegetation, channelization, and road construction. The lower segment of Libby Creek flows 14.8 miles from the Highway 2 bridge to its mouth at the Kootenai River. Note, the upper segment (MT76D002_061), which flows 11.2 miles from 1 mile upstream of Howard Creek to the Highway 2 bridge, is listed for two non-pollutant listings which may contribute excess sediment to the lower segment: alteration in streamside or littoral vegetative covers and physical substrate habitat alterations. The portion of the watershed upstream of highway 2 is a priority watershed for the KNF.

Physical Condition and Sediment Sources

Timber harvest in the lower watershed began in the 1930s and eventually the entire valley was clearcut at least once, including riparian areas (U.S. Department of Agriculture, Forest Service, 2002; Mineau and Brundin, 1999). Grazing is now mostly on private land, but historically grazing was widespread in the watershed (Mineau and Brundin, 1999). The riparian and valley land types are severely sensitive to disturbance and erosion, and are the areas where most of the land disturbing activities have occurred (U.S. Department of Agriculture, Forest Service, 2002).

The Lincoln Conservation District conducted a walking inventory of Libby Creek in 1991 from the mouth to 22 miles upstream (Lincoln Conservation District, 1991). The inventory concluded that the creek was fairly stable upstream of Highway 2 (i.e., the upper segment) but very unstable downstream. In the lower segment, 4 to 5 miles of eroding streambanks were measured on each side of the stream channel. The report attributed channel instability largely to piecemeal attempts to stabilize streambanks and straighten the channel, but also cited road construction, removal of riparian vegetation for agriculture and development, and the high bedload as factors (Lincoln Conservation District, 1991).

A 2000 master's thesis from University of Montana evaluated natural and human sources of channel instability but focused on the upper watershed because mining, logging, and road building since the 1950s have primarily occurred in that portion of the watershed (Sato, 2000). That study concluded that excess sediment associated with riparian vegetation removal and mining are the primary sources of instability in the upper watershed and that flood events have compounded the instability and caused shifts in channel morphology.

The Draft Environmental Impact Statement for the Montanore Project (U.S. Department of Agriculture, Forest Service, Kootenai National Forest and Montana Department of Environmental Quality, 2009) discusses habitat, sediment, and fisheries information but focuses on the upper watershed because of the project area location. Since this section is focused on the condition of the lower segment and source characterization, only a brief summary of data from that report is included. McNeil core values for fine sediment <6.25 mm ranged from 15 to 29%, and riparian habitat was rated as good or excellent at all but one site near historic placer operations (U.S. Department of Agriculture, Forest Service, Kootenai National Forest and Montana Department of Environmental Quality, 2009). Based on data collected in 2005, most reaches were overwidened and pool and LWD frequency were typically below the targets being applied in this document. Macroinvertebrate community health was variable and densities appeared to be affected by high flows but generally periphyton and macroinvertebrate communities were healthy (U.S. Department of Agriculture, Forest Service, Kootenai National Forest and Montana Department of Environmental Quality, 2009). DEQ recently analyzed the taxonomic composition of 14 samples collected by the KNF from 3 sites in the upper segment (**Figure 5-1**) and had similar findings. Taxa sensitive to water quality changes were dominant at all sites but some of the samples near the headwaters and just upstream of Highway 2 also contained midges that are indicative of habitat disturbance (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013).

There is some mass wasting of streambanks in the upper watershed, but it is prevalent along the lower segment (U.S. Department of Agriculture, Forest Service, 2002; Mineau and Brundin, 1999). Several streambank stabilization projects have been completed by FWP along the upper segment (upstream of Highway 2), and in 2001 a streambank stabilization project was conducted by FWP along a 1,700 foot reach at the upper end of the lower segment (Dunnigan, Jim, personal communication 8/26/2013). A rain-on-snow event in fall 2006 damaged several of the projects in the upper segment but the project in the lower segment largely remained intact. Rain-on-snow events are common in the watershed (particularly in streams draining the Cabinet Mountains), which makes maintenance of habitat improvement projects challenging (U.S. Department of Agriculture, Forest Service, Kootenai National Forest and Montana Department of Environmental Quality, 2009). However, the stabilization project in the lower segment successfully eliminated a large actively eroding streambank that contributed an estimated 5000 cubic yards of coarse and fine sediment annually to the system (Dunnigan, Jim, personal communication 8/26/2013). FWP monitoring indicates that the stream channel dimensions remain narrower and deeper than existed prior to restoration, and fish abundance has increased at this site after restoration (Dunnigan, Jim, personal communication 8/26/2013).

According to the Upper Kootenai Subbasin Review, Libby Creek contributes thousands of tons of fine sediment to the Kootenai River annually as a result of roads, timber harvest, culverts, upland erosion, and natural properties of the watershed (U.S. Department of Agriculture, Forest Service, 2002). Overall, the report noted that Libby Creek was very unstable with a high potential for flooding and high levels of large and fine sediment. The high mobility of the bedload in the entire lower segment was noted, and that factor combined with frequent channel changes was determined to be a contributing factor in the lack of LWD and pools (U.S. Department of Agriculture, Forest Service, 2002). Overall, the Upper Kootenai Subbasin Review concluded that decades of mining, road construction, timber harvest, and land development have harmed aquatic habitat throughout the watershed and that the most severe impacts are evident along the entire lower segment (U.S. Department of Agriculture, Forest Service, 2002).

Libby Creek was channelized with riprap between 1963 and 1995 for almost 2000 feet upstream of its mouth (Zelch, 2003; Sylvester and Stephens, 2013). The channel actively migrates and is aggrading along the riprapped section (Sylvester and Stephens, 2013). Similar to Quartz Creek, Libby Creek has a delta at its mouth. The delta has been investigated in several studies (along with deltas at the mouth of other Kootenai River tributaries downstream of Libby Dam) and found to be associated with the change in the Kootenai River flow regime because of Libby Dam and not because of excess sediment supply from Libby Creek (Sylvester and Stephens, 2013; Marotz et al., 1988; Dibrani, 2003; Zelch, 2003). However, Zelch (2003) did find that Libby Creek has an excess sediment supply that is exceeding its transport capacity.

In 2011, EPA collected sediment and habitat data at two sites on Libby Creek (**Figure 5-1**). The upper site, LIBY09-03, was located downstream of the Farm to Market – Hammer Cutoff road. The Stimson Haul Road was situated along the river left bank at the upstream end of the reach, including a stretch of riprap lined streambank. Extensive mid-channel gravel bar deposits indicate Libby Creek is aggrading in this reach; 2009 color aerial imagery indicates this condition extends along the entire sediment impaired segment of Libby Creek (which extends from the Highway 2 crossing to the mouth), which is the same section that was identified as being unstable and having highly mobile bedload as part of the Kootenai Subbasin Review. The large gravel bars contained numerous pieces of LWD (**Figure 5-4**). Streambanks were primarily composed of coarse gravel and small cobbles of similar size to the stream substrate. A layer of fine sediment, likely of lacustrine origin, overlay the gravel layer in some of the eroding banks. Some bank erosion appeared natural but it was largely attributed to the removal of riparian vegetation. Fine sediment was observed in the interstitial spaces of the coarse gravel substrate found in the long glides downstream of pools (**Figure 5-4**), which typically formed at the outsides of meander bends and in association with LWD. Relatively large substrate in the pool tail-outs likely limits spawning potential for all but the largest fish, but the degree to which reproduction is currently limiting trout populations in

Libby Creek is unknown. The riparian clearcutting that once occurred is evident in the even-aged mid-seral cottonwood stands along the channel. One local resident indicated that since the large cedar trees lining the stream were logged, the stream has been actively meandering, becoming overwidened, and transporting large quantities of bedload sediment. This observation is consistent with the channel changes that were observed after riparian vegetation was clearcut in the upper watershed (Sato, 2000). Understory shrub cover was sparse and extensive patches of knapweed were observed.

The lower site, LIBY09-05, also flowed next to the Stimson Haul Road, which encroached upon the stream channel upstream of the reach, and it included a stretch of riprap-lined streambank and a flow deflection feature extending into the channel. The substrate was slightly finer than at the upstream reach, but was similar in that it had extensive mid-channel gravel bar deposits, large gravel bars with LWD, streambanks of coarse gravel and small cobbles, and even-aged mid-seral cottonwood stands with sparse understory shrub cover. However, one large eroding streambank along the river left side of the channel where Libby Creek was eroding into the terrace was a source of finer material, as well as LWD. A small side channel along this eroding terrace had a dynamic series of pools formed by recent LWD inputs. Streambank erosion at this site was attributed to a mix of natural sources, riparian vegetation removal, and the road network. At both sites, it appeared that the mobile bedload is the primary source of sediment to Libby Creek, along with additional inputs from streambank erosion as the stream actively meanders across the floodplain.

Figure 5-4. Site LIBY09-03: Mid-channel gravel bars with LWD (left) and fine sediment within pool glides (right)

Comparison with Water Quality Targets

The existing data in comparison with the targets for Libby Creek are summarized in **Tables 5-14** and **5-15**. The macroinvertebrate bioassessment data are located in **Table 5-16**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-14. Existing sediment-related data for Libby Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
LIBY09-03	2011	82.3	C/D/F 3/4	C3/C4	8	7	7	8	**41.4**	**1.9**	2.5	13	304
LIBY09-05	2011	93.0	C/D/F4	C4	9	7	7	6	**41.6**	2.7	2.3	29	409

Table 5-15. McNeil Core Results for Libby Creek below Crazyman Creek (lower end of upper segment)
Values that exceed the target (26%) are in bold.

Year	2003	2004	2005	2006	2007	2008	2009	2010
Ave % <6.35mm	11.5	20.6	12	10	6	15.8	16	6

Table 5-16. Macroinvertebrate bioassessment data for Libby Creek
Values that do not meet the target threshold of 0.90 for O/E or <51% for periphyton are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
LIBY09-03	9/6/2011	DEQ – EMAP	**0.88**	20
LIBY09-05	9/6/2011	DEQ – EMAP	**0.82**	18

Summary and TMDL Development Determination

All fine sediment targets were met for the pebble count and grid toss. The McNeil Core values are from just above the lower segment but all samples met the target. Both sites were overwidened and exceeded the target for width/depth ratio, and the upper site was slightly entrenched and did not meet the entrenchment target. The residual pool depth target was met at both sites. Pool and LWD frequency was lower at the upper site but both sites met the targets. For the biological parameters, both sites met the periphyton target but were slightly below the O/E target. Because fine sediment at that site was low and the periphyton score does not indicate a problem, the value may be associated with bedload mobility near the mouth or other stressors.

Based on the recent data, excess fine sediment is not a widespread problem in lower Libby Creek. Fine sediment accumulations were observed in some pool tails though and given the streambank material and instability of the channel and streambanks, there is likely a substantial load of fine sediment to the system that is either being flushed downstream during high flow events or not apparent because of the aggradation of larger substrate. Habitat measures were met, which indicate the habitat may be improving over conditions documented in the Upper Kootenai Subbasin Review (U.S. Department of Agriculture, Forest Service, 2002). However, the 2011 field work did not document an improvement in channel stability; the overwidened and aggrading channel conditions that have been largely attributed to historical land management practices were observed at both sample sites and throughout the lower segment. Like Zelch (2003) found, recent observations indicate the sediment supply is exceeding the transport capacity. In addition to coarse sediment aggradation, the high mobility of the bedload and overall instability of the system is impeding its ability to fully support fish and aquatic life, particularly bull trout and other native trout species (Dunnigan, Jim, personal communication 8/26/2013). Based on the overwidened channel and excess sediment and the link to human sources and limitations to the fishery, a sediment TMDL will be developed for the lower segment of Libby Creek.

5.4.2.4 Quartz Creek (MT76D002_090)

Quartz Creek (MT76D002_090) is listed for sedimentation/siltation on the 2012 303(d) List. In addition, this segment is also listed for physical substrate alterations, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1992 because of excess sediment associated with timber harvest and roads. Quartz Creek flows 11.2 miles from its headwaters to its mouth at the Kootenai River.

Physical Condition and Sediment Sources

The Quartz Creek watershed was heavily harvested and had an extensive road network (U.S. Department of Agriculture, Forest Service, 2002). The DEQ assessment file notes logging roads, failing culverts, and erosion from channel instability as sediment sources. The file also notes a high precipitation event in 1996 that caused channel avulsion and channel braiding. The last major disturbance was a 1994 fire that burned 1,650 acres in the West Fork portion of the drainage and the subsequent timber salvage in 1995 (U.S. Department of Agriculture, Forest Service, 2002). Because it is an important spawning and rearing area for bull trout downstream of Libby Dam (Dunnigan et al., 2013), it has been the focus of extensive restoration work by the KNF since the early 1990s. The timber salvage in 1995 was conducted to be consistent with restoration goals (Wegner, 1998), which largely focused on addressing road-related issues: A large culvert was removed from the mainstem in 1995, numerous roads were recontoured, and in 1998 a road rehabilitation project was initiated that removed 9 culverts and decommissioned 11.6 miles of road in the West Fork watershed that had previously identified as sediment sources (U.S. Department of Agriculture, Forest Service, 2002). These projects reduced the road network in the West Fork portion of the drainage by 68% (Wegner, 1998). Additionally, LWD was placed in the channel, 800 feet of channel were dredged and reconstructed to address loading and channel avulsion associated with a slump on private land (Wegner, 1998), fireline fuel breaks were removed, and an additional 21.2 miles of road were removed from the system between 1995 and 1999 (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013).

Fisheries projects in the 1970s and 1980s removed LWD from the system; this affected the instream LWD, potential for recruitment, and the pool frequency (U.S. Department of Agriculture, Forest Service, 2002). However, the quality of the pools was noted to be high with several very deep pools in lower Quartz Creek. Substrate in the system is fairly unstable with significant annual bedload movement (U.S. Department of Agriculture, Forest Service, 2002) that is exacerbated by the frequency of high flow events (Dibrani, 2003). Also, there is a delta at the mouth that has caused aggradation in the lower section of the creek (U.S. Department of Agriculture, Forest Service, 2002; Dibrani, 2003). Several studies have investigated this delta (along with deltas at the mouth of other Kootenai River tributaries) and found it to be associated with the change in the Kootenai River flow regime because of Libby Dam and not because of excess sediment supply from Quartz Creek (Dibrani, 2003; Marotz et al., 1988; Sylvester and Stephens, 2013; Zelch, 2003).

Between 2003 and 2009, the KNF collected 13 macroinvertebrate samples from 4 sites (**Figure 5-1**). DEQ recently analyzed the taxonomic composition of the samples to help evaluate aquatic life beneficial-use support. Two samples collected near the mouth in 2006 and 2009 had mayflies that potentially indicate instream disturbance, but those samples and all others contained large quantities of several taxa that are very sensitive to changes in water quality (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013).

In 2011, EPA collected sediment and habitat data at two sites on Quartz Creek (**Figure 5-1**). The upper site, QRTZ03-01, was located in the upper watershed approximately five miles upstream of the West Fork Quartz Creek confluence. While a road parallels this portion of Quartz Creek, it is situated high up on the hillslope and does not appear to influence the stream channel. Timber harvest has occurred in the watershed upstream of this reach. The channel was lined by large cedar trees, with infrequent alder in the understory. The streambed was composed of gravel and small cobble substrate and most pools were formed by LWD. It appeared that the substrate size, pool frequency, and pool quality would provide ideal spawning conditions. Streambank erosion was limited and attributed to natural sources. This site appeared to be achieving its potential.

In addition to the assessment conducted on QRTZ03-01, the field crew also examined reaches QRTZ07-01 and QRTZ08-01 above and below the confluence with West Fork Quartz Creek. An erosive hillslope along river left was observed just downstream of the confluence and upstream of a small bedrock canyon. While human disturbances appeared absent along the stream channel in this area, evidence of timber harvest was observed on the adjacent hillslopes.

The lower site, QRTZ10-01, was located near the mouth of Quartz Creek. Activities that have influenced this site include timber harvest in the upper watershed, riparian harvest along the monitoring site, road encroachment, and LWD removal. This monitoring site was essentially comprised of one long riffle, with a couple of pools at the upper end of the monitoring site formed by LWD aggregates. One long eroding streambank was observed where the stream channel abuts a terrace and erosion was attributed to timber harvest and encroachment from the adjacent road. All other eroding streambanks were attributed to natural sources. Riparian vegetation along the channel margin includes conifers, cottonwoods, and alder. It appeared that a LWD aggregate at the upstream end of the reach was partially removed as evidenced by saw marks in the logs on both sides of the channel margin.

Comparison with Water Quality Targets

The existing data in comparison with the targets for Quartz Creek are summarized in **Tables 5-17** and **5-18**. The macroinvertebrate bioassessment data are located in **Table 5-19**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-17. Existing sediment-related data for Quartz Creek relative to targets

Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
QRTZ03-01	2011	18.7	B4c	B4c	13	8	3	4	17.9	2.2	1.4	90	480
QRTZ10-01	2011	38.5	B3	B3	7	4	3	3	25.7	1.5	**1.5**	26	338

Table 5-18. McNeil Core Results for Quartz Creek
Values that exceed the target (26%) are in bold.

Site/Year	2003	2004	2005	2006	2007	2008	2009	2010
Upstream of W Fork	19.3	19.5	**29**	19	16	21.6	23	21
Downstream of W Fork	26.3	19.9	21	20	17	**27.4**	**27**	20

Table 5-19. Macroinvertebrate bioassessment data for Quartz Creek
Values that do not meet the target threshold of 0.90 for O/E or <51% for periphyton are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
QRTZ03-01	9/8/2011	DEQ – EMAP	1.03	28
QRTZ10-01	9/8/2011	DEQ - EMAP	1.14	23

Summary and TMDL Development Determination

All riffle pebble count and grid toss targets were met and channel morphology parameters were within the expected range at both sites. The residual pool depth target was met at the upper site but was slightly below the target of 1.6 ft at the lower site. However, the Upper Kootenai Subbasin Review (U.S. Department of Agriculture, Forest Service, 2002) did document several very deep pools in lower Quartz Creek. Relative to the upper site, the effects of habitat disturbance on LWD and pool frequency is apparent, but both sites did meet the target for pool frequency and LWD frequency. For the biological parameters, the macroinvertebrate and periphyton samples were well within the target range at both sites.

Three of the core results exceed the 26% target, but the average since 2003 is 21% upstream of the West Fork and 22% downstream of the West Fork. Based on variability of core values in the KNF dataset, core values are naturally highly variable; therefore, more weight is given to long term trends than individual years. In a review of redd counts since 1995, the total count for all tributaries between Kootenai Falls and Libby Dam have been declining, but overall the population in Quartz Creek has been stable and not changed significantly since 1995 (Dunnigan et al., 2013). Although there is still evidence of the historical management practices, particularly in impacts to the habitat near the mouth, the restoration projects in the late 1990s and goals that continue to drive management actions in the watershed have expedited the watershed's recovery. Based on current land management practices that are mitigating human sources of sediment and the comparison of recent instream data to the targets, Quartz Creek is no longer impaired for sediment and a TMDL will not be written. The 303(d) listing status will be formally reevaluated by DEQ in the future.

5.4.2.5 Raven Creek (MT76C001_030)

Raven Creek (MT76C001_030) is listed for sedimentation/siltation on the 2012 303(d) List. In addition, this segment is also listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1992 because of excess sediment associated with timber harvest and roads. Raven Creek flows 3 miles from its headwaters to its mouth at the Pleasant Valley Fisher River, but there is no year-round surface flow for approximately 1.25 miles in the middle portion of the waterbody segment.

Physical Condition and Sediment Sources

The Raven Creek watershed has been highly impacted by fire and also heavily used for timber harvest. A Watershed and Fishery Analysis conducted as part of the Raven Crystal Environmental Assessment in 1990 concluded that the clearcut equivalent was 52% (Altman, 1990). The report stated that harvesting was initially selective but that extensive regeneration harvest occurred after the 1984 Houghton Creek fire and subsequent regeneration was unsuccessful. The Houghton Creek fire was severe, burning approximately 1,952 acres (88%) of the watershed (orange area in **Figure 5-5 inset**), and undoubtedly affected riparian vegetation, runoff rates, and sediment loading to Raven Creek. The disturbance caused by the fire was compounded by the post-fire harvest activities: the scale of the salvage harvest and associated road construction caused "extensive streambank cutting of 2 to 3 feet" because of increased runoff and a lack of LWD (Altman, 1990). High sediment loads were noted to be limiting the stream's ability to support fish, and no additional harvest or road building was recommended at that time (Altman, 1990). In 1996, Plum Creek Timber Company planted ponderosa pine trees within a 100 foot buffer of each side of the channel along a 1 mile section of Raven Creek (from lower RAVN03-01 to the USFS boundary in lower RAVN05-01, **Figure 5-5**) in areas where regeneration was unsuccessful and vegetation was sparse (Sugden, Brian, personal communication 01/08/2014). KNF field forms from 2002 to 2004 also noted the extensive logging in the 1980s, and concluded it changed peak flows and increased the sediment load in Raven Creek (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013).

DEQ performed an assessment in 2004 at site K02RAVNC01 in the lower watershed approximately 0.4 miles upstream of the Highway 2 crossing (**Figure 5-5**). At the time, the substrate was dominated by large gravel but had silt at the channel margins. A pebble count was performed and fine sediment <6mm was 36% and <2mm was 31%, both of which exceed the targets being applied in this document. Woody vegetation was identified as a major factor in controlling lateral erosion. Other notes were written about the watershed conditions: Timber harvest appeared the least intense near the headwaters, the dry middle portion of the waterbody segment (which corresponded to the most intensively harvested area) was incised and resembled a gully, and downstream of Highway 2 silt deposition was noted and the channel was narrow and deep.

In 2011, EPA performed a streambank erosion assessment at one site and a full assessment at two sites (**Figure 5-5**). The bank erosion site, RAVN04-01, was located 1.6 miles from the mouth on a dry ephemeral reach upstream of a road crossing. Just upstream of the site in reach RAVN03-01 (**Figure 5-5**), surface flow was observed. Logging and fire appeared to be the primary landscape scale disturbances along this site. The low streambanks were generally armored by cobble and the relatively straight cascading stream channel appeared to limit streambank erosion. Eroding streambanks were attributed to a combination of timber harvest and natural sources. Grass, small shrubs, and knapweed lined the channel margin. Given the lack of perennial flow, the riparian potential for the site is likely limited; however, vegetation around the site has improved quite a bit over the last 15 to 20 years (**Figure 5-6)**.

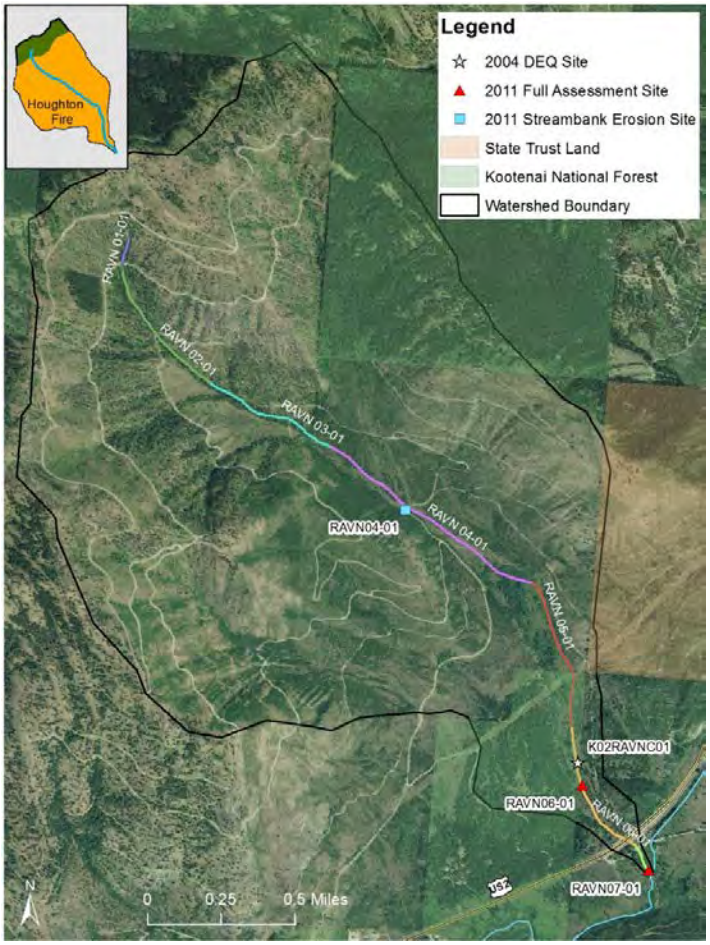

Figure 5-5. Raven watershed aerial photo (2009) showing stream reaches and sample sites. The inset shows the magnitude of the 1984 Houghton Fire

Figure 5-6. Looking downstream from the road at Raven Creek near RAVN04-01 in May 1994 (left) and July 2011 (right), photos courtesy of Plum Creek

In 2011, it appeared that Raven Creek had no perennial flow until the lower extent of reach RAVN05-01, where springs emerged and flowed into the channel (**Figure 5-5**). Because the entire stream except a reach downstream of Highway 2 was identified as having a valley gradient greater than 4%, the upper full assessment site, RAVN06-01, was slightly steeper than desired for observing the effects of excess sediment. However, the site was at almost the same location as the 2004 DEQ site (**Figure 5-5**), allowing the data and relative site conditions to be compared. The channel at RAVN06-01 was entrenched and had numerous small pools formed by small woody debris inputs. Streambank erosion was attributed to natural sources and limited by the small channel size, the degree of entrenchment, and dense woody vegetation along the stream channel margin. The substrate was comprised of gravel and small cobbles and free of fine sediment accumulations due to the high transport capacity of this reach. Alders formed a narrow band of vegetation along the channel margin, while the uplands were composed of weeds and small conifers.

RAVN07-01 was located near the mouth of Raven Creek, where it joins the Pleasant Valley Fisher River. Historic logging has occurred along this transitional reach where Raven Creek flows across the Fisher River floodplain. Stream substrate became finer in a downstream direction toward the mouth. The channel was small with grass-lined streambanks that limited streambank erosion. Alders were also present along the channel margin. The riparian vegetation was achieving its potential.

Comparison with Water Quality Targets

The existing data in comparison with the targets for Raven Creek are summarized in **Table 5-20**. The macroinvertebrate bioassessment data are located in **Table 5-21**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-20. Existing sediment-related data for Raven Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
RAVN06-01	2011	6.8	B4/E4b	B4	10	1	7	6	6.7	2.6	0.7	211	813
RAVN07-01	2011	5.2	E4	E4	**41**	**22**	**19**	**24**	5.5	6.9	0.6	**63**	454

Table 5-21. Macroinvertebrate bioassessment data for Raven Creek
Values that do not meet the target threshold (0.80 for the 2004 O/E, 0.90 for 2011 O/E, and <51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
K02RAVNC01	8/3/2004	Kick	0.91	--
RAVN06-01	9/5/2011	DEQ	**0.88**	44
RAVN07-01	9/5/2011	DEQ	**0.83**	43

Summary and TMDL Development Determination

All fine sediment targets were met at the upper site and all fine sediment targets were exceeded at the lower site. Compared to percent fine values for both size classes being greater than 30% in 2004, recent data from the upper site indicate a substantial improvement. Additionally, fine sediment was not observed at the channel margins as in 2004. At the lower site, all fine sediment targets were exceeded. The fine sediment targets being applied to the lower site are for an E channel, which are almost double the targets for B and C channel types, but there is some uncertainty regarding their applicability because Raven Creek downstream of the highway is in the floodplain for the Pleasant Valley Fisher River and achievable fine sediment values may differ from a typical E channel. However, some cells within the site did have pebble count and/or riffle grid toss values that met the target, indicating the targets are likely achievable. Given that reach RAVN07-01 is the only reach with a slope less than 4%, it is the most susceptible to excess sediment from the watershed and the last area where improvement is likely to be observed. Channel form parameters were within the expected range and met the target value at both sites. All instream habitat parameters met the targets at the upper site and all but the pool frequency target was met at the lower site. For the biological parameters, the periphyton samples were within the target range at both sites but two of the three macroinvertebrate samples did not meet the target.

It is unclear whether the Houghton Creek fire combined with the scale of harvest and road building caused the extent of subsurface flow that now exists, but it did increase sediment loads, destabilize streambanks, and cause channel downcutting. Although the extensive network of logging roads is still apparent (**Figure 5-5**), the roads assessment performed to support TMDL development found a high level of BMP implementation at crossings (**Appendix D**). Also, riparian vegetation throughout the stream has vastly improved and is helping stabilize streambanks and filter sediment from upland sources. Recent data and field observations indicate current management practices are facilitating the recovery of Raven Creek, but excess sediment is likely still limiting its ability to fully support aquatic life. Therefore, a sediment TMDL will be developed for Raven Creek.

5.4.2.6 Wolf Creek (MT76C001_020)

Wolf Creek (MT76C001_020) is listed for sedimentation/siltation on the 2012 303(d) List. In addition, this segment is also listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1988 because of excess sediment associated with channelization from the relocation of the Great Northern Railroad and erosion from timber harvest and roads. Wolf Creek flows 39.3 miles from its headwaters to its mouth at the Fisher River.

Physical Condition and Sediment Sources

One of the largest changes to Wolf Creek occurred when the Great Northern Railroad was relocated through the drainage in the mid to late 1960s because of Libby Dam. Some channelization occurred upstream of Little Wolf Creek but most of it occurred downstream, with 21% (~4 miles) being reconstructed and channelized, shortening Wolf Creek by 0.75 miles (Huston and May, 1970). The railway and adjusted channel cut through the Wolf Creek valley and floodplain, which contain highly erosive glacial till and lacustrine silt (Huston and May, 1970). There were difficulties re-establishing riparian vegetation in some areas of the creek and erosion was observed following construction along the railroad right-of-way, of cut and fill material, and of streambanks, particularly from just upstream of Little Wolf Creek to the mouth (**Figure 5-6**). The changes in flow dynamics caused by channelization not only affected streambank erosion, but also channel morphology and fish habitat: there were increases in the average channel depth and width, and the amount of backwater areas, which increased the sucker [fish] population (Huston and May, 1970).

The watershed has also been affected by grazing, timber harvest, and wildfires. Grazing started in the Little Wolf drainage in the early 1900s and then spread out to other areas (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Libby Ranger District, 1999). Near the headwaters in the Weigel drainage, road construction and timber harvest began in the 1960s and a portion of the drainage burned in 1988 (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 1996) (**Figure 5-7**). Approximately 44% of the watershed was harvested and over 38 miles of road were constructed. The extent of timber harvest has caused some streambank destabilization, but the level of disturbance has also caused the KNF to be concerned about upland erosion, cutbank slumping and debris slides, and limitations on revegetation potential (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 1996). Fires have also burned portions of the Dry Fork, Brush Creek, and Little Wolf subwatersheds since the 1980s (**Figure 5-7**), and Environmental Assessments conducted prior to [post-fire] salvage harvests summed up land management practices and channel conditions (USDA Forest Service, 1981; U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 1998; U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Libby Ranger District, 1999; Edwards, 2008). In the Dry Fork subwatershed, fire suppression, timber harvest, road and railroad construction, grazing, pine beetle, and wildfire were all noted as factors that are still affecting sediment deposition and channel conditions (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Libby Ranger District, 1999). Between wildfire and timber harvest, the equivalent clearcut area in Dry Fork reached almost 50% at one time, and increases in runoff associated with harvest were attributed to channel filling and braiding and streambank erosion. Channel instability in Dry Creek was also associated with a loss of riparian habitat caused by timber harvest followed by a combination of wildfire, harvest, road construction, and grazing (USDA Forest Service, 1981; U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Libby Ranger District, 1999). In Brush Creek, timber harvest, overgrazing, and increased peak flows were cited as causes of bank erosion, alterations to channel morphology, and excess sedimentation (Edwards, 2008). Removal of riparian vegetation and resulting channel instability was noted in general for tributaries to Wolf Creek and in associated with streambank erosion on Wolf Creek (Edwards, 2008). Restoration projects to address runoff from the road network, add LWD, and add riparian fencing were completed in conjunction with post-fire timber salvage projects (Edwards, 2008; U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Libby Ranger District, 1999).

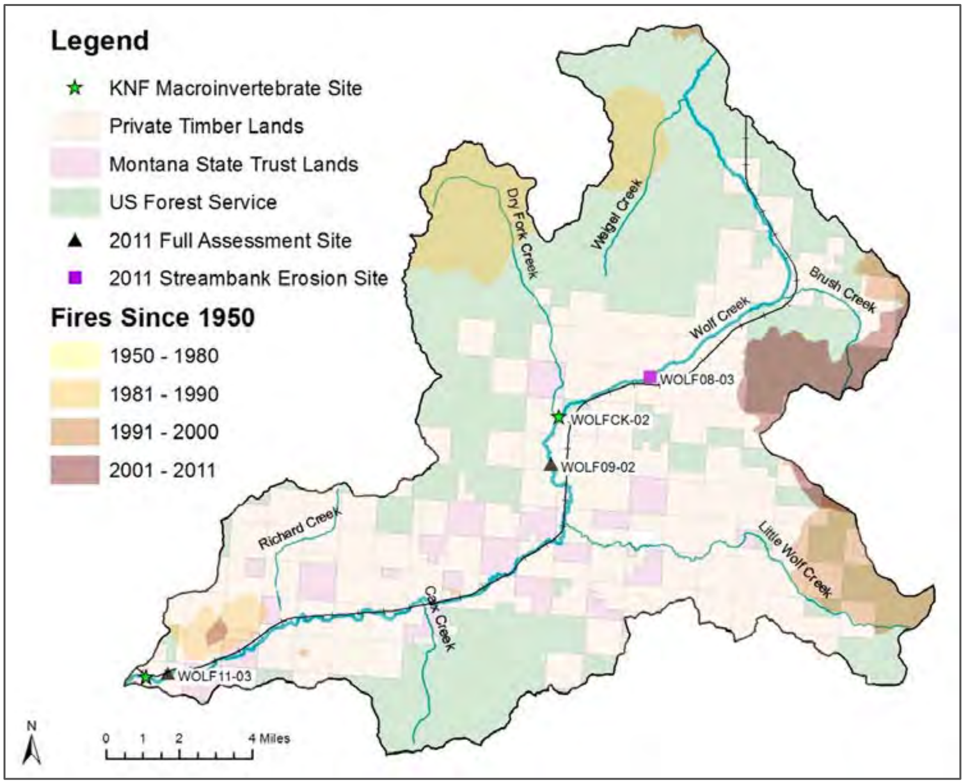

Figure 5-7. Wolf Creek watershed with sample sites, ownership, and fire history

DEQ visited three sites in 1992. At the time, the macroinvertebrates showed impairment from excess sediment. Lots of fine sediment was observed, especially near the mouth. Most of the overstory was noted to be gone from the valley and riprap was extensive, but shrub cover was good and limited grazing pressure on the stream. Extensive riprap and check dams were noted. Downstream of Little Wolf Creek, an unvegetated fire guard adjacent to the railroad track and eroding streambanks associated with channelization were noted to be the largest sources of sediment. Some beaver dams were observed near Little Wolf Creek but wetland vegetation was limited because the channel was incised. Closer to the canyon in the upper part of the watershed, channel alterations and riprap were also seen, as was evidence of historic logging, ongoing grazing, and BMP implementation at an active harvest area near the mouth of Rock Creek.

Between 2003 and 2009, the KNF collected 12 macroinvertebrate samples from 2 sites (**Figure 5-1**). DEQ recently analyzed the taxonomic composition of the samples to help evaluate aquatic life beneficial-use support. All samples at the upper site were dominated by taxa sensitive to changes in water quality, and all samples collected near the mouth contained sensitive taxa but were dominated by taxa that indicated instream habitat disturbance (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013).

In 2011, EPA performed a streambank erosion assessment at one site and a full assessment at two sites. A streambank erosion assessment was performed at WOLF08-03. Extensive logging has occurred in the Wolf Creek watershed upstream of this monitoring site. Grazing appears to be the primary land-use activity along the monitoring site, though overall grazing pressure appears relatively light. Streambanks were composed primarily of clay and silt and most streambank erosion appeared to be due to historic grazing activity and the loss of riparian vegetation, though historic logging and changes in water yield may also play a role. A fine layer of silt was observed on the streambed and the channel was slightly entrenched. The streambanks were lined with grass and the understory was dominated by alders.

The upper full assessment site, WOLF09-02, was located in a meadow area that has been grazed historically, though a recently constructed fence appeared to exclude grazing. Although the channel was entrenched, it was relatively sinuous and contained long runs and slow moving pools with an occasional short riffle. The substrate was predominantly fine material but was also covered with a layer of fine silt. Streambanks were composed primarily of clay and silt and the entrenched channel and most streambank erosion appeared to be due to historic grazing activity and the loss of riparian vegetation, though historic logging and changes in water yield may also play a role. Streambanks were lined with wetland sedges and grasses, with alders in the understory along the channel margin and very little overstory. The riparian vegetation appeared to be in a state of recovery and beaver activity was observed, though sediment contributions from eroding streambanks remain significant.

WOLF11-03 was located along the main road approximately 1.5 miles from the mouth. The monitoring site was situated so that the lower portion was located in a channelized area, while the upper portion was along a meander bend situated away from the road. As part of the channelization effort, it appeared that several grade control structures were added to Wolf Creek. During a review of 2009 color aerial imagery using GIS, 31 bridge crossings of Wolf Creek were identified, most of which were associated with the railroad. The streambed at the monitoring site was composed of large cobbles and small boulders, with riprap lining a portion of the reach, while natural streambanks generally contained large cobbles. Pools were relatively shallow and lacked spawning sized gravels. Alder and red osier dogwood lined the channel margin with conifers and a few cottonwoods in the overstory.

During field work in 2011, western pearlshell mussel shells were observed in portions of Wolf Creek. The Montana Natural Heritage Program surveyed Wolf Creek in 2007 for the mussel and conducted follow up checks in 2010 and 2012. A population with good viability was found in the lower watershed between Calx and Richard creeks, a relic shell with no live mussels was found near WOLF09-02, and several sites near and downstream of Little Wolf Creek had populations with no evidence of recent reproduction (Stagliano, David, personal communication 12/6/2012) (**Figure 5-7**). Although the mussel is sensitive to excessive siltation, the levels causing harm are unknown and its populations are also highly dependent on a salmonid host species, making it difficult to draw conclusions about the role of sediment in health of the Wolf Creek population (Stagliano, David, personal communication 12/6/2012).

Comparison with Water Quality Targets

The existing data in comparison with the targets for Wolf Creek are summarized in **Tables 5-22** and **5-23**. The macroinvertebrate bioassessment data are located in **Table 5-24**. All bolded cells are beyond the target threshold; depending on the target parameter, this may equate to being below or above the target value.

Table 5-22. Existing sediment-related data for Wolf Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean BFW (ft)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)		Channel Form (median)		Instream Habitat		
					% <6mm	% <2mm	Riffle % <6mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / Mile	LWD / Mile
Wolf Creek 5	2011	38.6	B4c	--	**--**	**--**	--	**--**	26.1	2.0	--	**14**	**14**
WOLF09-02	2011	29.7	B4c	C4	**16**	**16**	5	**11**	21.3	1.9	1.5	58	285
WOLF11-03	2011	45.1	F3	C3	6	5	0	--	27.2	**1.3**	1.6	**21**	**121**

Table 5-23. Average Annual McNeil Core Results for Wolf Creek
Values that do not meet the target are in bold.

Year	2003	2004	2005	2006	2007	2008	2009	2010
Upper Wolf	21.3	24.5	15	18	15	23.9	23	22
Lower Wolf	14.8	19.4	13	8	19	16.5	16	9

Table 5-24. Macroinvertebrate bioassessment data for Wolf Creek
Values that do not meet the target threshold (0.90 for O/E and <51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton %
WOLF09-02	9/6/2011	DEQ	**0.61**	24
WOLF11-03	9/5/2011	DEQ	**0.63**	25

Summary and TMDL Development Determination

The upper site exceeded the fine sediment target for both particles <6mm and <2mm in riffles by pebble count and also for particles <6mm in pool tails via grid toss. The lower site, which was mostly channelized and entrenched, met all fine sediment targets. All McNeil core samples met the target value. At all sites, the W/D ratio was within the expected range, but the entrenchment ratio was below the target at the entrenched lower site (WOLF 11-03). The residual pool depth met the target at both EPA sites, but pool and LWD frequency was below the target at the KNF site in the upper watershed and at the lower EPA site. For the biological parameters, the periphyton samples were well within the target range at both sites but both macroinvertebrate samples did not meet the target.

The highest achievable condition of the watershed is somewhat constrained by the extensive channelization and associated habitat changes caused by the railroad. However, timber harvest, roads, and grazing have also substantially altered the watershed, increased sediment loads to Wolf Creek, and caused streambank erosion and channel stability problems that persist. Although land management practices have improved, soils in the watershed are very sensitive to disturbance and field observations in combination with recent data indicate it is still recovering and excess sediment is limiting its ability to fully support aquatic life. This information supports the sediment impairment listing and a sediment TMDL will be developed for Wolf Creek.

5.5 SOURCE ASSESSMENT AND QUANTIFICATION

This section summarizes the assessment approach, current sediment load estimates, and the determination of the allowable load for each source category. DEQ determines the allowable load by estimating the obtainable load reduction once all reasonable land, soil, and water conservation practices have been implemented. The reduction forms the basis of the allocations and TMDLs provided in **Section 5.6**. This section focuses on four potentially significant sediment source categories and associated controllable human loading for each of these sediment source categories:

- streambank erosion
- upland erosion and riparian health
- unpaved roads
- permitted point sources

EPA's guidance for developing sediment TMDLs states that the basic procedure for assessing sources includes compiling an inventory of all sediment sources to the waterbody. In addition, the guidance suggests using one or more methods to determine the relative magnitude of loading, focusing on the primary and controllable sources (U.S. Environmental Protection Agency, 1999b). Federal regulations allow that loadings "may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (Water quality planning and management, 40 CFR 130.2(G), 2012).

For each impaired waterbody segment, sediment loads from each source category were estimated based on field surveys, watershed modeling, and load extrapolation techniques (described below). The results include a mix of sediment sizes, particularly for bank erosion that involves both fine and coarse sediment loading to the receiving water. Conversely, loading from roads, upland erosion, and permitted point source discharges are predominately fine sediment. The complete methods and results for source assessments for streambank erosion, upland erosion, and roads are found in **Attachments A** and **Appendices C** and **D**, respectively**.**

5.5.1 Eroding Streambank Sediment Assessment

Data collected during the 2011 Kootenai-Fisher sediment and habitat field work were used to estimate the total sediment load associated with bank erosion for each watershed. Streambank erosion was assessed in 2011 at the 15 assessment reaches discussed in **Section 5.3**. Each reach was walked and measurements were collected on both streambanks where bank erosion was observed. For each eroding streambank, channel cross section measurements were collected to indicate the erosive force (i.e., Near Bank Stress) (Rosgen, 1996; 2004), and measurements of the bank height, bankfull height, root depth, root density, bank angle, and surface protection were collected as indicators each streambank's susceptibility to erosion (i.e., BEHI). This information was used to calculate an annual sediment load for each monitoring site.

Because identifying the contribution from human sources is an important part of the source assessment and TMDL allocations, the sources of streambank erosion was evaluated based on observed human-caused disturbances and the surrounding land-use practices based on the following near-stream source categories:

- transportation
- riparian grazing
- cropland
- mining
- silviculture
- natural sources
- irrigation-shifts in stream energy
- other (e.g., past sources)

Whether using field observations, aerial photography, or GIS methodology, it is difficult to discern between bank erosion influenced from current or past human practices and bank erosion as a result of natural processes. However, a simple break down of the apparent erosion sources provides a general indicator of the activities that may be affecting bank erosion, which in turn could help land managers prioritize areas for improvement. The erosion sources identified for each reach, and summarized at the watershed scale, are provided in **Attachment A**.

Streambank erosion data from each 2011 monitoring site was used to calculate an annual load for that reach (as identified during the aerial assessment and stratification process described in **Section 5.3**). Because reaches were classified by ecoregion, stream order, and valley gradient/confinement, which may affect the background streambank erosion rate, the annual load from similar reach types was averaged and extrapolated to like reach types to estimate the annual load for each stream segment of concern. Note, the average reach type loads were also grouped and extrapolated depending on whether sources were identified in the field and via the aerial assessment process (discussed in **Section 5.3**) to be predominately natural (>75%) or attributable to human causes. Using a Wilcoxon rank sum test, the average annual load was significantly different ($\alpha \leq 0.17$ for all comparisons) between reach type categories and by predominant erosion source category. A more detailed description of the bank erosion assessment can be found in **Attachment A**.

5.5.1.1 Establishing the Total Allowable Load

Streambank erosion is a natural process typically dominated by slowly eroding streambanks. Human disturbances to riparian vegetation and health and/or stream hydrology can accelerate the natural erosion rate. This commonly occurs when streambanks shift from being well vegetated and/or armored (and commonly undercut) to being largely, or entirely, unvegetated with vertical banks. As discussed above, the annual bank erosion rate in reaches predominantly influenced by natural sources was significantly less than in those influenced by human sources. Therefore, the potential for reducing sediment loading from bank erosion was estimated by applying the erosion rate for reaches predominantly influenced by natural sources to all reaches where human sources are currently accelerating bank erosion. The “natural” erosion rate applied to establish the total allowable load is intended to represent bank erosion caused by natural sources and human sources when best management practices are used.

Tributaries to the 303(d) listed streams were included in the existing load estimate; however, because little is known about them, and the lowest erosion rate was applied to them, no reductions were applied to those waterbodies in determining the total allowable load at the watershed scale. The most appropriate BMPs will vary by site, and active restoration may be necessary to address some eroding banks, but streambank stability and erosion rates are largely a factor of the health of vegetation near the stream. Therefore, the load reductions are largely anticipated to be achieved by applying riparian BMPs. DEQ acknowledges that some streams may have a higher or lower background rate of eroding streambanks; thus, although the reduction may not be achievable in all areas, greater reductions will likely be achievable in some areas.

Assessment Summary

Based on the source assessment, streambank erosion loads range from 61 tons per year in the Raven Creek watershed to 5,659 tons per year in the Wolf Creek watershed (**Table 5-25**). Significant human-caused sources of streambank erosion include transportation (i.e., generally roads but also the railroad for Wolf Creek), timber harvest, removal of riparian vegetation, residential development, and grazing. Depending on the watershed, DEQ estimated that implementing riparian BMPs could decrease the human-caused level of streambank erosion by 10% to 32%. **Attachment A** contains additional information about the streambank erosion source assessment and associated load estimates for the

303(d) listed streams in the Kootenai-Fisher project area, including a breakdown by particle size class (i.e., coarse gravel, fine gravel, and sand/silt).

Table 5-25. Existing and Reduced Sediment Load from Eroding Streambanks in the Kootenai-Fisher Project Area

Subbasin	Existing Sediment Load (tons/year)	Existing Sediment Load (tons/mile/year)	Allowable Sediment Load with Riparian BMPs (tons/year)	Percent Reduction
Lake Creek	3,218	13.9	2,731	15%
Libby Creek	4,938	17.4	3,498	29%
Raven Creek	61	8.8	55	10%
Wolf Creek	5,659	19.9	3,867	32%

5.5.1.2 Streambank Assessment Assumptions

The following is a summary of the significant assumptions used during the assessment of eroding streambanks:

- The average annual rate of bank erosion at sites with predominantly natural sources is an appropriate and achievable rate in reaches where all reasonable land, soil, and water conservation practices are applied.
- The streambank erosion data collected during 2011 represents conditions within the watershed.
- The average annual load per reach type is applicable to other reaches within the same category.
- The assignment of influence to eroding streambanks and the distinction between natural and human-caused erosion is based on best professional judgment by qualified and experienced field personnel.
- Sources of bank erosion at the assessed stream segment scale are representative of sources for that watershed.
- The annual streambank erosion rates used to develop the sediment loading numbers were based on Rosgen BEHI studies in Colorado for sedimentary and metamorphic geologies (Rosgen, 2006). The Kootenai-Fisher project area primarily has metasedimentary geology (see **Appendix A**, **Figure A-4**); therefore, the erosion rates applied to help estimate the current loading from streambank erosion and the reductions achievable by implementing riparian BMPs are applicable to the project area.

5.5.2 Upland Erosion and Riparian Buffering Capacity Assessment

Upland sediment is that which originates beyond the stream channel. The erosion rate of sediment from upland sources is influenced by land use and/or vegetative cover. Sediment loading from upland erosion was modeled using a GIS application of the Universal Soil Loss Equation (USLE).

USLE uses five main factors to estimate soil erosion: R * K * LS * C * P, where

R = rainfall/intensity
K = erodibility
LS = length/slope
C = vegetation cover
P = field practices

All factors except for vegetation cover (C-factor) and field practices (P-factor) are environmental variables unaffected by management practices. Because the P-Factor generally relates to practices occurring at a finer scale than is practical for establishing TMDLs in the project area, it was set at 1 for all scenarios. To estimate the existing upland load associated with each land-use category, adjustments were made to the C-Factor, which integrates a number of variables that influence erosion, including vegetative cover, plant litter, soil surface, and land management.

The existing sediment load delivered to each 303(d) listed stream was estimated by combining the USLE model results with a sediment delivery ratio that accounts for downslope travel distance to surface water, along with a riparian buffer factor that reflects ability of buffers to filter sediment from runoff. The ability of existing riparian vegetation to reduce upland sediment loads was based on a riparian health classification performed for the left and right streambank of each 303(d) listed waterbody during the stratification process described in **Section 5.3**. Buffer health was classified into five categories, which ranged from good (i.e., a dense riparian buffer) to poor (i.e., a mix of bare ground and no woody shrubs, in areas with potential for shrub cover). Based on studies that have found that a well-vegetated riparian buffer filters 75% to 90% of incoming sediment from reaching the stream channel (Wegner, 1999; Knutson and Naef, 1997), a 75% removal efficiency was applied to good buffers; this was scaled down to 50% and 30% for fair and poor buffers, respectively.

5.5.2.1 Establishing the Total Allowable Load

The allowable load from upland erosion, which is associated with implementing BMPs, was determined by a two-fold approach: (1) C-factors for human-influenced land-use categories were modified to reflect the improvement in ground cover that is expected by implementing upland BMPs and (2) riparian health was improved to represent the additional decrease in upland sediment loading that will occur by implementing riparian BMPs.

The land-use categories with modified C-factors were grasslands/herbaceous and pasture/hay. The C-factor change equated to an approximate 10% improvement in ground cover per category. Timber harvest also has the potential to contribute upland sediment, but the C-factor was kept the same for both scenarios because upland loading from this source is mitigated by conditions specified in Montana's Streamside Management Zone law and within the Plum Creek and Department of Natural Resources & Conservation (DNRC) Habitat Conservation Plans (Montana Department of Natural Resources and Conservation, 2010; Plum Creek Timber Co., 2000). The C-factor values for both scenarios (i.e., existing and improved conditions) were based on literature values, stakeholder input, and field observations. DEQ acknowledges that C-factor values are variable within land-use categories throughout the watershed and over time; however, because of the model's scale, DEQ assumed that values for ground cover were consistent throughout each land-use category and throughout the year.

The potential for improvements in riparian health was based on the existing riparian health classification, a review of aerial imagery, and on-the-ground verification. It is important to note that under the improved-conditions scenario, a significant portion of the remaining sediment load, after BMPs are implemented in human-influenced land-use categories, is also a component of the natural background load. Additionally, the allocation to human sources includes both present and past influences and is not meant to represent only current management practices. Many of the restoration practices that address current land use will reduce pollutant loads that are influenced from historic land uses. A more detailed description of the assessment can be found in **Appendix C**.

Assessment Summary

Sediment loads from upland erosion range from 31 tons/year in the Raven Creek watershed to 1,209 tons/year in the Lake Creek watershed (**Table 5-26**). Since this assessment was conducted at the watershed scale, DEQ expects larger watersheds to have greater sediment loads. A significant portion of the sediment load from upland erosion is contributed by natural sources, but the estimated contribution by all land-use categories is provided in **Appendix C**. By implementing upland and riparian BMPs, annual loading reductions are expected to range from 10% to 19%. Improvement in riparian health comprises greater than 98% of the estimated reduction in annual loading from upland sources.

Table 5-26. Existing and Reduced Sediment Loads from Upland Erosion in the Kootenai-Fisher Project Area

Subbasin	Existing Delivered Sediment Load (tons/year)	Improved Upland and Riparian Conditions Sediment Load (tons/year)	Percent Reduction
Lake Creek	1,209	1,085	10%
Libby Creek	876	709	19%
Raven Creek	31.1	25.6	18%
Wolf Creek	807	705	13%

5.5.2.2 Upland Assessment Assumptions

As with any modeling effort, and especially when modeling at a watershed scale, a number of assumptions are made. The following is a summary of the significant assumptions used during the assessment of upland erosion:

- The USLE model is sufficiently accurate for the level of detail needed for sediment TMDLs in this project area. This empirical model was selected for this source assessment because it is well suited for large watersheds and incorporates local climate and landscape data, but it is not overly data-intensive.
- The data sources used are reasonable and appropriate to characterize the watershed and build the model.
- The input variables used in the USLE calculations represent their respective land-use conditions.
- The land management practices that define the vegetative cover throughout the year are relatively consistent and represent practices throughout the watershed.
- The riparian condition as estimated through the aerial assessment and field-verified represents on-the-ground conditions. Riparian buffer health was included to emphasize its importance in reducing upland sediment loading; however, DEQ acknowledges the classification and improvement potential was conducted at a coarse scale.
- The improvement scenarios to riparian condition and land management are reasonable and achievable.
- The USLE model provides an appropriate level of detail and is sufficiently accurate for developing upland sediment loads for TMDL purposes.

5.5.3 Unpaved Road Sediment Assessment

Roads located near stream channels can reduce stream function by degrading riparian vegetation, encroaching on the channel, and adding sediment. The degree of harm is determined by a number of factors, including road type, construction specifications, drainage, soil type, topography, and precipitation, as well as the usage and maintenance of BMPs. Unpaved roads were identified as a potentially significant sediment source for this project area and were the primary focus of the roads source assessment. However, culverts can pose a substantial risk for sediment loading and fish passage, and were also evaluated as part of the roads source assessment.

5.5.3.1 Erosion from Unpaved Road Crossings

Sediment loading from the unpaved road network in the Kootenai-Fisher project area was assessed using GIS, field data, and modeling. Prior to field data collection, GIS tools were used to identify each road crossing and near-stream parallel road segment and assign attributes for road name, surface type (i.e., native, gravel, paved), road ownership, stream name, and subwatershed. In 2011, 47 unpaved crossings were field assessed. At almost half of the sites, there was no defined stream crossing or the road had been closed. The lack of a defined stream channel at such a high number of sites was a factor of the high resolution stream layer (1:100,000 NHD) used to initially identify road crossings. The percentage of randomly selected crossings with no defined channel (21%) was used when modeled loads for field sites were extrapolated to the watershed scale to reduce the number of GIS-identified crossings that are potentially contributing sediment.

Although the majority of the field assessed crossings were pre-selected at random with the goal of collecting data at a representative subset of crossings, some additional sites were added in the field because of the large number that were lacking a defined stream crossing or were inaccessible. Ultimately, a suite of measurements related to road composition, traffic level, and contributing distance for eroding sediment were collected at 24 sites. Additionally, the location and type of existing BMPs and potential locations for additional BMPs (if necessary) were recorded. No near-stream parallel road segments were officially assessed because parallel segments were determined to be an insignificant component of road-related sediment loading; this determination was based on no evidence of loading being observed from these road segments and the robustness of most roadside buffers in the project area.

All field measurements were input into the Water Erosion Prediction Project (WEPP): Road soil erosion model to calculate an annual sediment load per crossing. Because precipitation is a key driver of erosion and it varies largely across the project area (**Appendix A**, **Figure A-10**), the project area was divided into three precipitation zones, and crossing loads were modeled in WEPP using climate data to reflect those zones. Because of differences observed in the field and in WEPP-generated loads between Federally-managed and private/county/state managed crossings, modeled loads were grouped by ownership in addition to climate zone before being averaged. This resulted in an average annual load per Federal and non-Federal crossing in each precipitation zone that was then extrapolated to all road crossings in the watershed based on ownership and precipitation zone.

5.5.3.2 Establishing the Total Allowable Load

For unpaved road crossings, the allowable load was determined by re-entering the 2011 field data into the WEPP: Road model and reducing the contributing distance for each crossing to the length identified in the field where a BMP could potentially be added. This process was used to provide a more customized approach than using a set reduction or contributing length per crossing, however, the distances used still are not intended to be prescriptive measures. The optimal location for additional BMPs is ultimately up to the road owner. The overarching goal is to ensure that all road crossings have the appropriate BMPs in place to protect water quality via reduced sediment loading. BMPs that may be used to either reduce the contributing length, or achieve the allowable load, include installing full structural BMPs at existing road crossings (drive through dips, culvert drains, settling basins, silt fence, etc.), improving the road surface, and reducing traffic levels (seasonal or permanent road closures). Although the estimated reductions may not be possible at all locations because of site-specific conditions or existing BMPs, additional loading reductions will likely be achievable at other locations.

Assessment Summary

Based on the source assessment, the sediment load from unpaved roads ranges from 0.17 ton/year in the Raven Creek watershed to 6.9 tons/year in the Libby Creek watershed (**Table 5-27**). In general, private/county roads had a higher proportion of crossings with adequate BMPs than federal roads (i.e., 5/7 vs. 4/17, respectively). This trend is also apparent in the contributing lengths when broken down by jurisdiction: the average contributing length at all private/county crossings was 60 feet and the average contributing length at all federal crossings was 167 feet. However, conditions for unpaved roads within the project area are generally good for all ownership categories. Most loading is coming from a limited number of crossings with inadequate or improperly maintained BMPs.

At fourteen of the crossing approaches, sufficient BMPs are already in place. The most common BMPs observed were rolling dips and water bars. Both of these BMPs interrupt the flow of water, reducing the amount of road surface that water can erode as it moves towards the stream channel (i.e., the contributing length). Based on measurements taken at crossings where additional BMPs are recommended, loading reductions ranging from 32% to 51% (**Table 5-27**) are achievable. Reductions are slightly greater for federally administered roads than private/county/state roads, but because of the greater average load per crossing at federal crossings, reductions at the subwatershed scale were similar. A more detailed description of this assessment, including the loads broken down by jurisdiction, can be found in the Road Sediment Assessment report (**Appendix D**).

Table 5-27. Annual Sediment Load (tons/year) from Roads in the Kootenai-Fisher Project Area

Watershed	Total Load (tons/year)*	Percent Load Reduction After BMP Application	Total Sediment Load After BMP Application*
Lake Creek	4.8	50%	2.4
Libby Creek	6.9	51%	3.4
Raven Creek	0.172	32%	0.116
Wolf Creek	5.7	47%	3.0

*Because of rounding, differences in loads presented in this table may not correspond to the percent reduction.

5.5.3.3 Culvert Failure and Fish Passage

Undersized or improperly installed culverts may be a chronic source of sediment to streams, or a large acute source during failure. They may also be passage barriers to fish. Therefore, during the roads assessment, the flow capacity and potential to be a fish passage barrier was evaluated for each culvert. After crossings with no culvert were excluded, the culvert analysis was performed at 21 of the 24 field assessed road crossings. The assessment incorporated bankfull width measurements taken upstream of each culvert to determine the stream discharge associated with different flood frequencies (e.g. 2, 5, 10, 25, 50, and 100 year), as well as measurements to estimate the capacity and amount of fill material of each culvert. DEQ assumed that fill above an undersized culvert will periodically erode into the channel, but the culvert will not completely fail; therefore, the annual amount of sediment at-risk was set at a 25% probability for the loading analysis.

A common BMP for culverts is designing them to accommodate 25-year storm events; this capacity is specified as a minimum in Water Quality BMPs for Montana Forests (Montana State University Extension Service, 2001), and it is typically the minimum used by the USFS. Therefore, fill was only assumed to be at-risk in culverts that cannot convey a 25-year event. However, other considerations, such as fish passage, the potential for large debris loads, and the level of development and road density upstream of the culvert, should also be considered during culvert installation and replacement. When these are factored in, larger culverts may be necessary. For instance, USFS typically designs culverts to pass the 100-year event, while also accommodating fish and aquatic organism passage on fish bearing streams (U.S. Department of Agriculture, Forest Service, 1995). Therefore, the BMP scenario for culverts is no loading from culverts as a result of being undersized, improperly installed, or inadequately maintained. At a minimum, culverts should meet the 25-year event. For fish-bearing streams, or those with a high level of road development upstream, meeting the 100-year event is recommended.

Fish passage assessments were performed on 18 culverts. The majority of these culverts were located on streams containing fish as evaluated by Montana Fish, Wildlife and Parks, though this was not considered when evaluating a culvert's ability to pass fish (**Appendix D**, **Figure 3-3**). Sites where all measurements could not be collected, as well as sites lacking perennial flow, were excluded. The assessment was based on the methodology defined in **Appendix D**, which is geared toward assessing passage for juvenile salmonids. Considerations for the assessment include streamflow, culvert slope, culvert perch/outlet drop, culvert blockage, and constriction ratio (i.e., culvert width to bankfull width). The assessment is intended to be a coarse level evaluation of fish passage that quickly identifies culverts that are likely fish barriers and those that need a more in-depth analysis. The culvert assessment in **Appendix D** contains information that may help land managers focus restoration efforts on those culverts that were deemed fish barriers and/or undersized per this analysis.

Assessment Summary

Out of the 21 culverts assessed for failure risk, 19 (90%) were estimated to pass a 25-year event, and 15 (71%) were estimated to pass the 100-year event. Both crossings not passing the 25-year event and five of the six crossings not passing the 100-year event were on road crossings administered by the USFS. Considering that approximately 60% of road crossings in the project area are administered by the USFS, this is not surprising. Although we evaluated a relatively small sampling of all the culverts, these findings indicate that landowners in the project area are very aware of the importance of properly sized culverts and have been diligent about installing appropriately sized culverts and replacing inadequate ones.

The two culverts that are predicted to pass less than a 25-year recurrence interval flood appear to be at a relatively high risk of failure. Should they fail, up to 180 tons of sediment is at risk of being contributed to the road-related sediment load. However, because of the sporadic nature and uncertainty regarding timing of culvert failures, the estimated load at-risk is not included in the existing loads estimates for each impaired stream.

For the fish passage assessment, 17 of 18 culverts were determined to pose a significant passage risk to juvenile fish at all flows. The predominant reason cited as a barrier to fish was a steep culvert gradient. Recent research suggests fish can pass steeper culverts than indicated by the screening tool used for this assessment (Burford et al., 2009; Peterson et al., 2013), particularly if there is no outlet drop (Peterson et al., 2013). When gradients up to 8% are considered at culverts with no outlet perch, five additional culverts may pass some fish. As this is a very coarse assessment, additional evaluations should be conducted at any culvert that may be replaced to facilitate fish passage.

5.5.3.4 Road Assessment Assumptions

The following is a summary of the significant assumptions used during the roads assessment:

- The road crossings assessed in the field represent conditions throughout the watershed.
- The WEPP: Road model reasonably characterizes the existing sediment loads and potential for load reductions for the road and climate conditions observed in the Kootenai-Fisher project area.

- Using modeling scenarios that focus reducing the contributing length near road crossings will effectively reduce the majority of the sediment load from roads. This is an effective way to represent loading reductions associated with implementing all reasonable, land, soil, and water conservation practices.
- BMPs may have already have been implemented on many roads, and therefore the reductions necessary in some locations may be less than described in this document.

5.5.4 Permitted Point Sources

As of September 23, 2013, the Kootenai-Fisher project area had 11 Montana Pollutant Discharge Elimination System (MPDES) permitted point sources within sediment-impaired watersheds (**Appendix A, Figure A-18**). All of the permits fall within the Libby Creek watershed; none of them are located on the lower segment but because they all have the potential to contribute sediment that could flow into the lower segment, they were all evaluated. There is one individual permit issued to the Montanore Minerals Corporation (MT0030279) for reclamation and exploration at the Montanore Mine site, but all other permits are general. Nine of the general permits are for suction dredge (MTG370000) and one is construction storm water (MTR104874). To provide the required wasteload allocation (WLA) for permitted point sources, a source assessment was performed for these point sources. Because of the conditions set within all of the applicable permits, and the nature of sediment loading associated with these permits, the WLAs are not intended to add load limits to the permits; DEQ assumed that the WLAs will be met by adhering to the permit requirements.

5.5.4.1 Montanore Minerals Corporation

Individual Permit (MT0030279)

The permit has been administratively continued since 2011 and is being evaluated for renewal by DEQ. DEQ conducted compliance inspections in August 2005 and February 2011 and found no violations during either inspection. The mine is not currently active, but the site has an exploration adit, a water treatment plant, and a percolation pond, and there are three permitted outfalls. Based on the renewal application, Montanore Minerals Corporation plans to continue using the water treatment plant, adit, and permitted outfalls and to add two new adits, a tailings storage facility, a plant/mill facility, and five stormwater outfalls. Additionally, it would like to use one of the existing outfalls (#1) for stormwater; because this outfall also receives adit discharge, it will receive water that goes to the water treatment plant and a percolation pond before being discharged to groundwater.

Only one of the currently permitted outfalls (#3) could potentially discharge directly to Libby Creek, but it has not been constructed. When it is active, it will discharge from a percolation pond and may also receive treated effluent from the water treatment plant. The effluent limit for the three permitted outfalls corresponds to the Effluent Limit Guidelines for Discharges from Active Ore (Metal) Mining and Dressing Sites: a daily maximum Total Suspended Solids (TSS) concentration of 30 mg/L and a monthly average TSS concentration of 20 mg/L (40 CFR, §440.104(a)). There is no flow limit in the permit but the permittee estimates a typical discharge from outfall #3 of 0.8021 cfs. Based on sample data collected between 2008 and 2010 from the water treatment plant, the average TSS concentration in the outfall effluent is anticipated to be 1 mg/L. Since other source water to the outfall will be from a percolation pond, which allows for solids to settle, 1 mg/L seems like a reasonable estimate for the outfall effluent. At a flow rate of 0.8021 cfs, this equates to 0.8 tons/year, which is much less than the permitted load of 15.8 tons/year (assuming a concentration of 20 mg/L and 0.8021 cfs flow rate). The median TSS concentration from samples collected quarterly from Libby Creek at the future discharge location for outfall #3 (at LB-300) between 2006 and 2010 as part of the existing permit requirements is <1 mg/L.

This indicates the typical discharge concentration will be similar to that found in Libby Creek. Alternatively, if the concentration of the outfall effluent were at the monthly permit limit of 20 mg/L during critical low flow conditions (i.e., 7Q10) of 2.22 cfs, the concentration in Libby Creek would increase from 1 mg/L to 6 mg/L TSS. Based on monitoring data at LB-300 and farther upstream (LB-200), 6 mg/L is within the concentration range that occurs near the mine site and well below that anticipated to harm aquatic life (Newcombe and Jensen, 1996).

All five of the proposed stormwater outfalls will discharge to surface water: two will discharge to Libby Creek, one will discharge to Ramsey Creek (a tributary), and two will discharge to Poorman Creek (a tributary). Since both Ramsey and Poorman are tributaries to Libby Creek, all outfalls will be considered for this evaluation. Four of the proposed stormwater outfalls will collect runoff from access/haul roads and one will collect runoff from an adit pad, but none of the stormwater from the proposed outfalls is anticipated to contact waste rock or other mining-related material. According to supporting information in the permit file, all stormwater from the site will be collected in ditches and sediment ponds, and the outfalls would only be used for stormwater that exceeds the onsite storage capacity. Ditches and ponds will be sized to contain the 10-year, 24-hour storm event. Based on PRISM data referenced in the permit application, the average annual precipitation at the site is 35 inches. The combined drainage area contributing to the five proposed stormwater outfalls is 20.7 acres. Assuming no runoff is retained and the TSS concentration is 100 mg/L (which is the benchmark value provided in the General Industrial Stormwater Permit to assess successful BMP implementation), 8.2 tons of sediment could runoff annually. Using BMPs that maximize the onsite storage capacity, as well as BMPs that minimize the contributing length along the haul roads, is expected to greatly reduce sediment loading from the stormwater outfalls. Particularly since the BMPs are being designed to retain the 10-year, 24-hour storm event, the annual load will likely be much lower than this estimate. The BMPs discussed in the renewal application will be included in the Stormwater Pollution Prevention Plan (SWPPP) that will accompany the final permit.

The WLA for permit MT0030279 will be 24 tons/year based on the sum of the permitted monthly load to outfall #3 and the estimated load from the stormwater outfalls (15.8 tons and 8.2 tons, respectively). As stated above, this WLA is not intended to add load limits to the permits. Based on the current permit conditions and stormwater BMPs discussed in the renewal application, the intent of the WLA will be met by adhering to the permit requirements.

Construction Stormwater Permit (MTR104874)

Since construction activities at a site are relatively temporary and short term in nature, the number of construction sites covered by the general permit at any given time varies. Collectively, these areas of severe ground disturbance have the potential to be significant sediment sources if proper BMPs are not implemented and maintained. Each construction stormwater permittee is required to develop a SWPPP that identifies the stormwater BMPs that will be in place during construction. Prior to permit termination, disturbed areas are required to have a vegetative density equal to or greater than 70% of the pre-disturbed level (or an equivalent permanent method of erosion prevention). Inspection and maintenance of BMPs is required, and although Montana stormwater regulations provide the authority to require stormwater monitoring, water quality sampling is typically not required (Heckenberger, Brian, personal communication 2009).

The construction stormwater permit at the Montanore Mine site is for surface construction and underground exploration. According to the permit file, the site mostly has a flat gradient and 12 acres are anticipated to be disturbed. BMPs in place include vegetative buffer zones, sediment traps, berms and ditches, a storage pond for runoff from the main adit area with no discharge, and a pond for runoff from the former waste rock storage area. Based on the site layout and BMPs in place, no discharge is anticipated to Libby Creek. Therefore, a WLA of 0 will be provided and is anticipated to be met by adherence to permit conditions. Because following permit conditions meets the intent of the WLA for construction stormwater, any future permits will meet the TMDL by following all permit conditions, including the SWPPP.

5.5.4.2 Suction Dredge Permits (MTG370000)

There are currently nine suction dredge permits in the Libby Creek watershed. The Suction Dredge General Permit describes portable suction dredges and their operation as “mechanical devices that float on the stream surface and pump stream water and stream bed material through a suction dredge intake to a sluice box, from which gold or other precious metals are recovered. Unwanted gravels and other naturally occurring stream bottom material fall off the end of the sluice box and are redeposited back onto the stream bottom. Since the discharge consists of naturally occurring stream bottom material and no chemicals are allowed to be added to enhance gold recovery, there is no additional load of pollutants to the receiving stream.” The general permit has special conditions to minimize harmful conditions caused by elevated suspended sediment concentrations:

- No disturbance of the streambanks or streambank vegetation
- No visual increase in turbidity (cloudiness or muddiness) observable at the end of the mixing zone. The mixing zone is defined as 10 stream widths downstream of the suction dredge.
- No visible oil sheen caused by the suction dredge operation.
- No discharge of floating solids or visible foam in other than trace amounts.
- No added chemicals allowed in the discharge.

Additionally to protect the fishery during spawning and fry emergence, all permits are seasonally limited to dredge between July 15 and September 1.

Assessment Summary

Because only sediment within the wetted channel is permitted and no visual increase is allowed beyond the mixing zone, if the permit conditions are followed, no sediment loading is anticipated from these permits. Therefore, a composite WLA of 0 will be provided for the suction dredge permits in the Libby Creek watershed.

Because following permit conditions meets the intent of the WLA for suction dredge, any future permits will meet the TMDL by following all permit conditions.

5.5.5 Source Assessment Summary

Based on field observations and associated source assessment work, all assessed source categories represent significant controllable loads. Each source category has different seasonal loading rates, and the relative percentage of the total load from each source category does not necessarily indicate its importance as a loading source. Instead, because of the coarse nature of the source assessment work, and the unique uncertainties involved with each source assessment category, the intention is to separately evaluate source effects within each assessment category (e.g., bank erosion, upland erosion, roads). Results for each source assessment category provide an adequate tool to focus water quality restoration activities in the Kootenai-Fisher project area; they indicate the relative contribution of different subwatersheds or landcover types for each source category and the percent loading reductions that can be achieved with the implementation of improved management practices (**Appendix C** and **D** and **Attachment A**).

5.6 TMDL AND ALLOCATIONS

The sediment TMDLs for the Kootenai-Fisher project area will be based on a percent reduction approach, discussed in **Section 4.0.** This approach will apply to the loading allocated among sources as well as to the TMDL for each waterbody. Each impaired segment's TMDL consists of any upstream allocations. An implicit margin of safety will be applied, further discussed in **Section 5.7**.

5.6.1 Application of Percent Reduction and Yearly Load Approaches

Cover et al. (2008) observed a correlation between sediment supply and instream measurements of fine sediment in riffles and pools. DEQ assumed that a decrease in sediment supply, particularly fine sediment, will correspond to a decrease in the percent fine sediment deposition within the streams of interest and result in attaining sediment-related water quality standards. A percent-reduction approach is preferable because there is no numeric standard for sediment to calculate the allowable load and because of the uncertainty associated with the loads derived from the source assessment (which are used to establish the TMDL), particularly when comparing different load categories, such as road crossings to bank erosion. Additionally, the percent-reduction TMDL approach is more applicable for restoration planning and sediment TMDL implementation because this approach helps focus on implementing water quality improvement practices (BMPs) versus focusing on uncertain loading values.

An annual expression of the TMDLs was determined as the most appropriate timescale because sediment generally has a cumulative effect on aquatic life and other designated uses, and all sources in the watershed are associated with periodic loading. Each sediment TMDL is stated as an overall percent reduction of the average annual sediment load that can be achieved after summing the individual annual source allocations and dividing them by the existing annual total load. EPA encourages TMDLs to be expressed in the most applicable timescale but also requires TMDLs to be presented as daily loads (Grumbles, Benjamin, personal communication 2006). Daily loads are provided in **Appendix E**.

5.6.2 Development of Sediment Allocations by Source Categories

The percent-reduction allocations are based on BMP scenarios for each major source type (e.g., streambank erosion, upland erosion, roads, and permitted point sources). These BMP scenarios are discussed in **Section 5.5** and associated appendices/attachments. They reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. Sediment loading reductions can be achieved through a combination of BMPs, and the most appropriate BMPs will vary by site. Sediment loading was evaluated at the watershed scale and associated sediment reductions are also applied at the watershed scale based on the fact that many sources deliver sediment to tributaries that then deliver the sediment load to the impaired waterbodies.

It is important to recognize that the first critical step toward meeting the sediment allocations involves applying and/or maintaining the land management practices, or BMPs, that will reduce sediment loading. Once these actions have been completed at a given location, the landowner or land manager will have taken action consistent with the intent of the sediment allocation for that location. For many nonpoint source activities, it can take several years to decades to achieve the full load reduction at the location of concern, even though full BMP implementation is in effect. For example, it may take several years for riparian areas to fully recover after implementing grazing BMPs or allowing re-growth in areas of past riparian harvest. It is also important to apply proper BMPs and other water quality protection practices for all new or changing land management activities to limit any potential increased sediment loading.

Progress toward TMDL and individual allocation achievement can be gaged by adhering to point source permits, implementing BMPs for nonpoint sources, and improving or attaining the water quality targets defined in **Section 5.4**. Any effort to calculate loads and percent reductions for comparison with TMDLs and allocations in this document should be accomplished via the same methodology and/or models used to develop the loads and percent reductions presented within this document.

The following subsections present additional allocation details for each sediment source category.

5.6.2.1 Streambank Erosion

Streambank stability and erosion rates are closely linked to the health of the riparian zone. Reductions in sediment loading from bank erosion are expected to be achieved by applying BMPs within the riparian zone. Sediment loads associated with bank erosion are identified by separate source categories (e.g., transportation, grazing, natural) in **Attachment A**; however, because of the inherent uncertainty in extrapolating this level of detail to the watershed scale, and also because of uncertainty regarding the effects of past land management activity, all sources of bank erosion were combined to express the TMDL and allocations.

DEQ acknowledges that the annual sediment loads, and the method by which to attribute human and historic influence, are estimates based on aerial photography, best professional judgment, and limited access to on-the-ground reaches. The assignment of bank erosion loads to the various land uses is not definitive but was done to direct efforts to reduce the loads toward those causes that are likely having the biggest effect on the investigated streams. Ultimately, local land owners and managers are responsible for identifying the causes of bank erosion and for adopting practices to reduce bank erosion wherever practical.

5.6.2.2 Upland Erosion

The allocation to upland sources includes application of BMPs to present land-use activities as well as recovery from past land-use influences, such as riparian harvest. No reductions were allocated to natural sources, which are a significant portion of all upland land-use categories. For all upland sources, the largest percent reduction will be achieved via riparian improvements. The anticipated loading reductions achievable by implementing upland and riparian BMPs for each land cover category are presented in **Appendix C**. For the TMDL, the allocation to upland erosion sources is presented as a single load and percent reduction.

5.6.2.3 Roads

The allocation to roads can be met by incorporating and documenting that all road crossings with potential sediment delivery to streams have the appropriate BMPs in place. Routine maintenance of the BMPs is also necessary to ensure that sediment loading remains consistent with the intent of the allocations. Although near-stream parallel road segments (i.e., within 150 feet) were excluded from the unpaved road source assessment because of the general condition and composition of the roadside vegetative buffer in the watersheds for the streams of concern, current conditions should be maintained where sediment is not a source from parallel roads and additional BMPs will be needed if there are or become parallel segments that are sources of sediment. The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culverts. At a minimum, culverts should meet the 25-year event; however, for fish-bearing streams and streams with a high level of road and impervious surface development upstream, or for culvert sites with a large amount of fill, meeting the 100-year event is recommended.

5.6.2.4 Permitted Point Sources

All WLAs are expected to be met by adhering to permit conditions and loads provided within this document are not intended to be incorporated into permit limits or added to permit conditions.

5.6.3 Allocations and TMDL for Each Stream

The following subsections present the existing quantified sediment loads, allocations, and TMDL for each waterbody (**Tables 5-28** through **5-31**). Note, sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

5.6.3.1 Lake Creek (MT76D002_070)

Table 5-28. Sediment Source Assessment, Allocations and TMDL for Lake Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Roads	4.8	2.4	50%
Streambank Erosion	3,218	2,731	15%
Upland Sediment Sources	1,209	1,085	10%
Total Sediment Load	**4,432**	**3,818**	**14%**

5.6.3.2 Libby Creek, lower segment (MT76D002_062)

Table 5-29. Sediment Source Assessment, Allocations and TMDL for lower Libby Creek

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Roads		6.9	3.4	51%
Streambank Erosion		4,938	3,498	29%
Upland Sediment Sources		876	709	19%
Point Source	Montanore Mine (MT0030279)	0	24	0%
	Suction Dredge (MTG370000)	0	0	0%
	Construction Stormwater (MTR100000)	0	0	0%
Total Sediment Load		**5,821**	**4,234**	**27%**

5.6.3.3 Raven Creek (MT76C001_030)

Table 5-30. Sediment Source Assessment, Allocations and TMDL for Raven Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Roads	0.17	0.12	32%
Streambank Erosion	61	55	10%
Upland Sediment Sources	31	26	18%
Total Sediment Load	**92**	**81**	**12%**

5.6.3.4 Wolf Creek (MT76C001_020)

Table 5-31. Sediment Source Assessment, Allocations and TMDL for Wolf Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Roads	5.7	3.0	47%
Streambank Erosion	5,659	3,867	32%
Upland Sediment Sources	807	705	13%
Total Sediment Load	**6,472**	**4,575**	**29%**

5.7 SEASONALITY AND MARGIN OF SAFETY

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety were applied during development of the Kootenai-Fisher project area sediment TMDLs.

5.7.1 Seasonality

All TMDL documents must consider the seasonal applicability of water quality standards as well as the seasonal variability of pollutant loads to a stream. Seasonality was addressed in several ways:

- The applicable narrative water quality standards (**Appendix B**) are not seasonally dependent, although low-flow conditions provide the best ability to measure harm-to-use based on the selected target parameters. The low-flow or base-flow condition represents the most practical time period for assessing substrate and habitat conditions, and also represents a time period when high fine sediment in riffles or pool tails will likely influence fish and aquatic life. Therefore, meeting targets during this time frame represents an adequate approach for determining standards attainment.
- The substrate and habitat target parameters within each stream are measured during summer or autumn low-flow conditions consistent with the time of year when reference stream measurements are conducted. This time period also represents an opportunity to assess effects of the annual snow runoff and early spring rains, which is the typical time frame for sediment loading to occur.
- The DEQ sampling protocol for macroinvertebrates identifies a specific time period for collecting samples based on macroinvertebrate life cycles. This time period coincides with the low-flow or base-flow condition.
- All assessment modeling approaches are standard approaches that specifically incorporate the yearly hydrologic cycle specific to the project area. The resulting loads are expressed as average yearly loading rates to fully assess loading throughout the year.
- Allocations are based on average yearly loading, and the preferred TMDL expression is as an average yearly load reduction, consistent with the assessment methods.

5.7.2 Margin of Safety

Natural systems are inherently complex. Any approach used to quantify or define the relationship between pollutant loading rates and the resultant water quality effects, no matter how rigorous, will include some level of uncertainty or error. To compensate for this uncertainty and ensure water quality standards are attained, a margin of safety (MOS) is required as a component of each TMDL. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999b). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to assess a broad range of physical and biological parameters known to illustrate the effects of sediment in streams and rivers. These targets serve as indicators of potential impairment from sediment and also help signal recovery, and eventual standards attainment, after TMDL implementation. Conservative assumptions were used during development of these targets; as discussed for each target parameter in **Section 5.4.1**, an effort was made to select achievable water quality targets, but in all cases, the most protective statistical approach was used. **Appendix B** contains additional details about statistical approaches used by DEQ.
- The C-factor and Sediment Reduction Efficiency values used to estimate sediment loading from upland sources were based on conservative literature values (i.e., allowing for more sediment erosion and delivery).
- When reducing the number of road crossings identified in GIS for the extrapolation, only the percentage of crossings encountered in the field with no defined channel (21%) were used. The percentage of field sites that had a paved approach or were not accessible (28%) was not used to adjust the number of GIS-identified stream crossings that potentially contribute sediment from the road network.
- By developing TMDLs for streams which were close to meeting all target values. This approach addresses some of the uncertainty associated with sampling variability and site representativeness and recognizes that capabilities to reduce sediments exist throughout the watershed.
- Sediment impairment is typically identified based on excess fine sediment but the targets and TMDLs address both coarse and fine sediment delivery.
- By properly incorporating seasonality into target development, source assessments, and TMDL allocations (details provided in **Section 5.7.1**).
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development (discussed in **Sections 5.10**, **9.0**, and **10.0**).
- By using naturally occurring sediment loads as described in ARM 17.30.602(17) (see **Appendix B**) to establish the TMDLs and allocations based on reasonably achievable load reductions for each source category. Specifically, each major source category must meet percent reductions to satisfy the TMDL because of the relative loading uncertainties between assessment methodologies.
- By developing TMDLs at the watershed scale to address all potentially significant human-related sources beyond just the impaired waterbody segment scale. This approach should also reduce loading and improve water quality conditions within other tributary waterbodies throughout the watershed.

5.8 TMDL DEVELOPMENT UNCERTAINTY AND ADAPTIVE MANAGEMENT

A degree of uncertainty is inherent in any study of watershed processes. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management is a key component of TMDL implementation. The process of adaptive management is predicated on the premise that TMDLs, allocations, and their supporting analyses are not static but are subject to periodic modification or adjustment as new information and relationships are better understood. Within the Kootenai-Fisher project area, adaptive management for sediment TMDLs relies on continued monitoring of water quality and stream habitat conditions, continued assessment of effects from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fish respond to changes in water quality and stream habitat conditions.

As noted in **Section 5.7.2**, adaptive management represents an important component of the implicit MOS. This document provides a framework to satisfy the MOS by including sections focused on TMDL implementation, monitoring, and adaptive management (**Sections 9.0** and **10.0**). Furthermore, state law (ARM 75-5-703) requires monitoring to gauge progress toward meeting water quality standards and satisfying TMDL requirements. These TMDL implementation monitoring reviews represent an important component of adaptive management in Montana.

Perhaps the most significant uncertainties within this document involve the accuracy and representativeness of (a) field data and target development and (b) the accuracy and representativeness of the source assessments and associated load reductions. These uncertainties and approaches used to reduce uncertainty are discussed in following subsections.

5.8.1 Sediment and Habitat Data Collection and Target Development

Some of the uncertainties regarding accuracy and representativeness of the data and information used to characterize existing water quality conditions and develop water quality targets are discussed below.

Data Collection

The stream sampling approach used to characterize water quality is described in **Attachment A**. To control sampling variability and improve accuracy, the sampling was done by trained environmental professionals using a standard DEQ procedure developed for creating sediment TMDLs (Montana Department of Environmental Quality, 2011a). This procedure defines specific methods for each parameter, including sampling location and frequency, to ensure proper representation and applicability of results. Before any sampling, a sampling and analysis plan (SAP) was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP and was based on a stratification process described in **Attachment A**. The stratification work ensured that each stream included one or more sample sites representing a location where excess sediment loading or altered stream habitat could affect fish or aquatic life.

Even with the applied quality controls, a level of uncertainty regarding overall accuracy of collected data will exist. There is uncertainty regarding whether the appropriate sites were assessed and whether an adequate number of sites were evaluated for each stream. Also, there is the uncertainty of the representativeness of collecting data from one sampling season. These uncertainties are difficult to quantify and even more difficult to eliminate given resource limitations and occasional stream access problems.

Target Development

DEQ evaluated several data sets to ensure that the most representative information and most representative statistic was used to develop each target parameter, consistent with the reference approach framework outlined in **Appendix B**. Using reference data is the preferred approach for target setting; however, some uncertainty is introduced because of differing protocols between the available reference data and recent sample data for the project area. These differences were acknowledged within the target development discussion and taken into consideration during target setting. For each target parameter, DEQ stratified the Kootenai-Fisher sample results and target data into similar categories, such as stream width or Rosgen stream type, to ensure that the target exceedance evaluations were based on appropriate comparison characteristics.

The established targets are meant to apply under median conditions of natural background and natural disturbance. DEQ recognizes that under some natural conditions, such as a large fire or flood event, it may be impossible to satisfy one or more of the targets until the stream and/or watershed recovers from the natural event. Under these conditions the goal is to ensure that management activities do not significantly delay achievement of targets compared with the time for natural recovery to occur.

Also, human activity should not significantly increase the extent of water quality effects from natural events. For example, extreme flood events can cause a naturally high level of sediment loading that could be significantly increased from a large number of road crossing or culvert failures.

Because sediment target values are based on statistical data percentiles, DEQ recognizes that it may be impossible to meet all targets for some streams even under normal levels of disturbance. On the other hand, some target values may underestimate the potential of a given stream, and it may be appropriate to apply more protective targets upon further evaluation during adaptive management. It is important to recognize that the adaptive management approach provides flexibility to refine targets as necessary to ensure resource protection and to adapt to new information concerning target achievability.

5.8.2 Source Assessments and Load Reduction Analyses

Each assessment method introduces uncertainties regarding the accuracy and representativeness of the sediment load estimates and percent load reduction analyses. For each source assessment, assumptions must be made to evaluate sediment loading and potential reductions at the watershed scale. Because of these uncertainties, conclusions may not represent existing conditions and achievable reductions at all locations in the watershed. Uncertainties are discussed independently for the three major nonpoint source categories: bank erosion, upland erosion, and unpaved road crossings. Additional details about uncertainties associated with the source assessments are contained in the associated attachments/appendices.

Bank Erosion

Bank erosion loads were initially quantified using the DEQ protocols (Montana Department of Environmental Quality, 2011a) and the standard BEHI methodology, defined in **Attachment A**. Before any sampling, a SAP was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP and was based on a stratification process described in **Attachment A**. The results were then extrapolated across the project area to provide an estimate of bank erosion loading to the stream segments of concern. Based on this process, the relative contribution from human versus natural sources, as well as the potential for reduction with the implementation of riparian BMPs, was estimated and used for TMDL allocations. Because of the small sample size for each unique reach type, and even for the reach types groupings that were used for the extrapolation, there is a high degree of uncertainty in the average annual load estimates that were extrapolated to the stream segment and watershed scale. For this reason, the loads are intended to provide a relative sense of the loading associated with bank erosion from human and natural sources for each watershed.

There is additional uncertainty regarding the amount of bank erosion linked to human activities and the specific human sources, as well as the ability to reduce the human-related bank erosion levels. This uncertainty is largely associated with identifying sources at the stream segment scale using aerial photos and also because of the heavy influence from past disturbances; it is extremely difficult to identify the level to which historical occurrences still affect streambank erosion, how much is associated with human sources, and what the dominant human sources are. Even if difficult to quantify, the linkages between human activity, such as riparian clearing and bank erosion, are well established, and these linkages clearly exist at different locations throughout the Kootenai-Fisher project area. Evaluating bank erosion levels, particularly where BMPs have been applied along streams, is an important part of adaptive management that can help define the level of human-caused bank erosion as well as the relative effect that bank erosion has on water quality throughout the Kootenai-Fisher project area.

Upland Erosion

A professional modeler determined upland erosion loads by applying a landscape soil loss equation (USLE), defined in **Appendix C**. As with any model, there will be uncertainty in the model input parameters, including land use, land cover, and assumptions regarding existing levels of BMP application. For example, only one vegetative condition was assigned per land cover type. In other words, the model cannot reflect land management practices that change vegetative cover from one season to another, so an average condition is used for each scenario in the model. The potential to reduce sediment loading was based on modest land cover improvements, along with riparian improvements, to reduce the generation of eroded sediment particles. Thus, there is uncertainty regarding existing erosion prevention BMPs and the ability to reduce erosion with additional BMPs.

The upland erosion model integrates sediment delivery based on riparian health; riparian health evaluations linked to the stream stratification work are discussed in **Attachment A**. The riparian health classifications were performed using aerial imagery and a coarse classification system (i.e., poor, poor/fair, fair, fair/good, and good). This particularly introduced uncertainty in watersheds that had limited woody vegetation but that may have had a high buffering capacity from other vegetation, such as wetland grasses. However, field verification and adjustment of the original classifications as well as the potential improvement was conducted to help reduce the uncertainty.

The riparian health analysis was not performed with the expectation that it would identify specific locations for implementation of additional BMPs. Instead it was performed to simulate the buffering capacity of riparian vegetation and emphasize the importance of a healthy riparian buffer. Even with these uncertainties, the ability to reduce upland sediment erosion and delivery to nearby waterbodies is well documented in literature, and the estimated reductions are consistent with literature values for riparian buffers.

Roads

As described in **Appendix D**, the road crossings sediment load was estimated via a standardized simple yearly model developed by USFS. This model relies on a few basic input parameters that are easily measured in the field, as well as inclusion of precipitation data from local weather stations. A total of 47 sites were visited in the field, representing about 3% of the total population of roads. The results from these sites were extrapolated to the whole population of roads stratified by ownership and precipitation class. Random selection of the stratified sites was intended to capture a representative subset of the road crossings for existing conditions and level of BMP implementation. However, some uncertainty is introduced because of the small sample size relative to the total number of road crossings.

Although the culvert assessment is a coarse level assessment, there is uncertainty in the peak flow capacity that was calculated for each culvert because it is based on regional regression equations, which may substantially overestimate or underestimate peak flow. The fish passage assessment indicated most culverts are problematic for fish passage, which is a little surprising given the high percentage of culverts estimated to pass greater than a 100-year storm event. Although there is a fair amount of uncertainty with any rapid assessment tool, such as the fish passage assessment, there is uncertainty associated with the fish passage conclusion because the assessment uses criteria that differ from that found by some recent research, which means fish passage rates may be higher than indicated by this analysis. The conclusions of the analysis were not used for the TMDL and are not intended to be used for decision-making but instead to raise awareness about the importance of proper culvert installation and maintenance, and to be a general indicator of potential fish passage issues at the watershed scale.

6.0 NUTRIENTS TMDL COMPONENTS

This section focuses on nutrients (nitrate + nitrite [NO_3+NO_2], total nitrogen [TN], and total phosphorus [TP] forms) as a cause of water quality impairment in the Kootenai-Fisher project area. It includes 1) nutrient impairment of beneficial uses; 2) specific stream segments of concern; 3) currently available data on nutrient impairment assessment in the watershed, including target development and a comparison of existing water quality targets; 4) quantification/description of nutrient sources based on recent studies; and 5) identification and justification for nutrient TMDLs and TMDL allocations.

6.1 EFFECTS OF EXCESS NUTRIENTS ON BENEFICIAL USES

Nitrogen and phosphorus are natural background chemical elements required for the healthy and stable functioning of aquatic ecosystems. Streams in particular are dynamic systems that depend on a balance of nutrients, which is affected by nutrient additions, consumption by autotrophic organisms, cycling of biologically fixed nitrogen and phosphorus into higher trophic levels, and cycling of organically fixed nutrients into inorganic forms with biological decomposition. Additions from natural landscape erosion, groundwater discharge, and instream biological decomposition maintain a balance between organic and inorganic nutrient forms. Human influences may alter nutrient cycling pathways, causing damage to biological stream function and water quality degradation.

Excess nitrogen in the form of dissolved ammonia (which is typically associated with human sources) can be toxic to aquatic life. Elevated nitrates in drinking water can inhibit normal hemoglobin function in infants. Besides the direct effects of excess nitrogen, elevated inputs of nitrogen and phosphorus from human sources can accelerate aquatic algal growth to nuisance levels. Respiration and decomposition of excessive algal biomass depletes dissolved oxygen, which can kill fish and other forms of aquatic life. Nutrient concentrations in surface water can lead to blue-green algae blooms (Priscu, 1987), which can produce toxins lethal to aquatic life, wildlife, livestock, and humans.

Aside from toxicity, nuisance algae can shift the macroinvertebrate community structure, which also may affect fish that feed on macroinvertebrates (U.S. Environmental Protection Agency, 2010). Additionally, changes in water clarity, fish community structure, and aesthetics can harm recreational uses, such as fishing, swimming, and boating (Suplee et al., 2009). Nuisance algae can increase treatment costs of drinking water or pose health risks if ingested in drinking water (World Health Organization, 2003).

6.2 STREAM SEGMENTS OF CONCERN

There are four waterbody segments in the Kootenai-Fisher project area that are on the 2012 Montana 303(d) List for nutrient impairments – Bristow Creek, Lake Creek, Raven Creek, and Stanley Creek (**Figure 6-1**). However, recent data indicate Bristow Creek is no longer impaired for nutrients, and it will be delisted for TN on the 2014 303(d) List. **Table 6-1** summarizes the nutrient impaired stream segments addressed in this document.

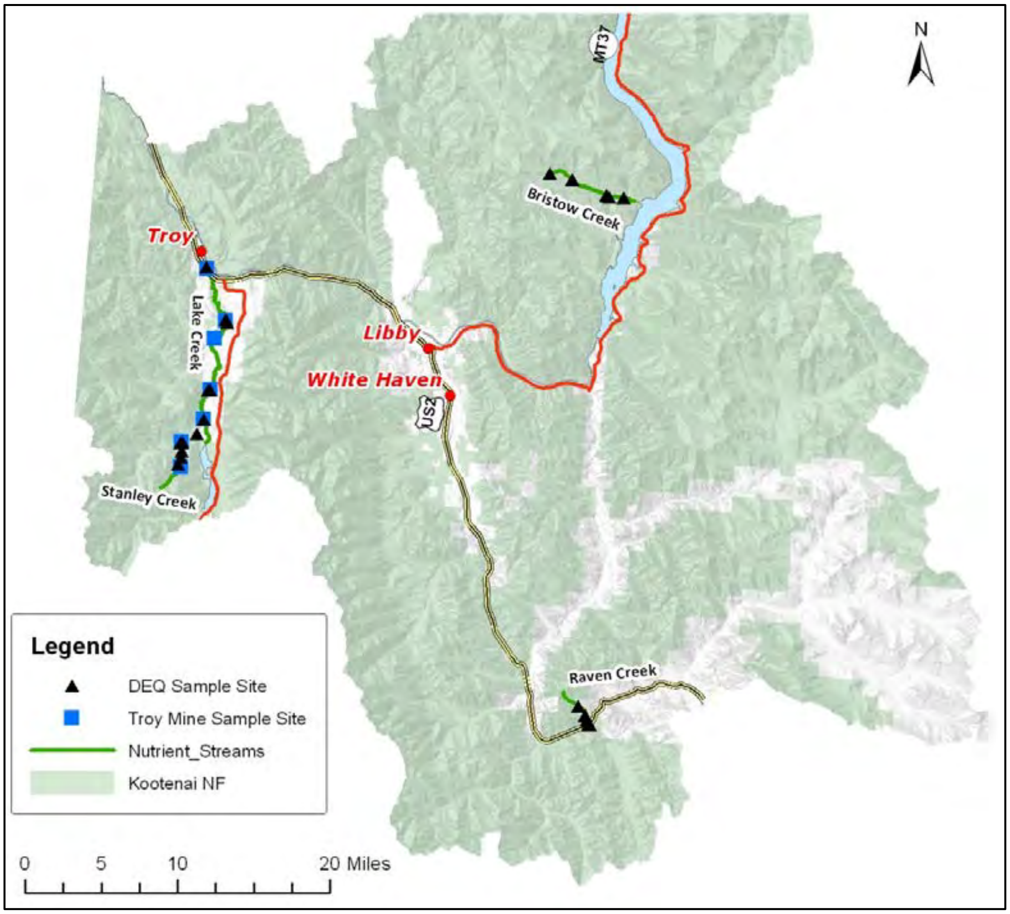

Figure 6-1. Stream segments of concern in the Kootenai-Fisher Project Area

Table 6-1. Nutrient impaired stream segments addressed in the Kootenai-Fisher Project Area

Stream Segment	Waterbody ID
LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)	MT76D002_070
RAVEN CREEK, headwaters to mouth (Pleasant Valley Fisher River)	MT76C001_030
STANLEY CREEK, Headwaters to the mouth	MT76D002_010

6.3 INFORMATION SOURCES AND ASSESSMENT METHODS

To assess nutrient conditions for TMDL development, DEQ compiled nutrient data and undertook additional monitoring. The following data sources represent the primary information used to characterize water quality.

1) **TMDL Sampling:** DEQ and EPA conducted water quality sampling from 2011 through 2013 to update impairment determinations and assist with the development of nutrient TMDLs. Sample locations were generally such that they provided a comprehensive upstream to downstream view of nutrient levels. All data used in TMDL development were collected during the growing season for the Northern Rockies Level III Ecoregion (July 1 – September 30). Benthic algae samples were collected for each stream and analyzed for chlorophyll-*a* and ash-free dry mass (AFDM). Macroinvertebrate samples were also collected in each stream.

2) **Troy Mine Data:** Water quality data were obtained from the Troy Mine for Stanley Creek and Lake Creek. Data were available from multiple sites on both streams spanning from 2003-2011 (**Figure 6-1**).

3) **DEQ Assessment Files:** These files contain information used to make the existing nutrient impairment determinations.

Nutrient data used for impairment assessment purposes and TMDL development are included in **Appendix F**. Other nutrient data from the watershed is publicly available through EPA's STORET and DEQ's EQuIS water quality databases.

Additional sources of information used to develop TMDL components include the following:

- Streamflow data
- GIS data layers
- Forest Service National Environmental Protection Act (NEPA) documents
- Land-use information

The above information and water quality data are used to compare existing conditions to waterbody restoration goals (targets), to assess nutrient pollutant sources, and to help determine TMDL allocations. Field data sheets were reviewed to rule out irregularities in collection methods or sample Quality Assurance/Quality Control (QA/QC). Laboratory methods and QA/QC criteria were also reviewed to ensure these values were accurate. Nothing was found to indicate that any results were anomalous.

6.4 WATER QUALITY TARGETS

TMDL water quality targets are numeric indicator values used to evaluate whether water quality standards have been met. These are discussed further in **Section 4.0**. This section presents nutrient water quality targets and compares them with recently collected nutrient data in the Kootenai-Fisher project area following DEQ's draft assessment methodology (Suplee and Sada de Suplee, 2011). To be consistent with DEQ's draft assessment methodology, and because of improvements in analytical methods, only data from the past 10 years are included in the review of existing data.

6.4.1 Nutrient Water Quality Standards

Montana's water quality standards for nutrients (nitrogen and phosphorous) are narrative and are addressed via narrative criteria. Narrative criteria require state surface waters to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: 1) produce conditions that create concentrations or combinations of material toxic or harmful to aquatic life, and 2) create conditions that produce undesirable aquatic life (ARM 17.30.637 (1) (d-e)). DEQ is currently developing numeric nutrient criteria for TN and TP that will be established at levels consistent with narrative criteria requirements. These draft numeric criteria are the basis for the nutrient TMDL targets and are consistent with EPA's guidance on TMDL development and federal regulations.

6.4.2 Nutrient Target Values

Nutrient water quality targets include nutrient concentrations in surface waters and measures of benthic algae (a form of aquatic life that at elevated concentrations is undesirable) chlorophyll-*a* concentrations and AFDM. The target concentrations for nitrogen and phosphorus are established at levels believed to prevent the harmful growth and proliferation of excess algae. Since 2002, DEQ has conducted a number of studies in order to develop numeric criteria for nutrients (N and P forms). DEQ is developing draft numeric nutrient standards for TN, TP, chlorophyll-*a* and AFDM based on 1) public surveys defining what level of algae was perceived as “undesirable” (Suplee et al., 2009), and 2) the outcome of nutrient stressor-response studies that determine nutrient concentrations that will maintain algal growth below undesirable and harmful levels (Suplee and Watson, 2013). Although dissolved fractions of phosphorus and nitrogen do not have draft numeric nutrient criteria because uptake by aquatic organisms can make their concentrations highly variable, DEQ has determined that nitrate is an important constituent to evaluate in conjunction with TN and TP (Suplee and Watson, 2013).

Nutrient targets for TN and TP (which are also draft numeric criteria), chlorophyll-*a*, and AFDM are based on Suplee and Watson (2013) and can be found in **Table 6-2**. The NO_3+NO_2 target is based on research by DEQ (Suplee, Michael W., personal communication 11/14/2013) and can also be found in **Table 6-2**. DEQ has determined that the values for NO_3+NO_2, TN, and TP provide an appropriate numeric translation of the applicable narrative nutrient water quality standards based on existing water quality data in the Kootenai-Fisher project area. The target values are based on the most sensitive uses; therefore, the nutrient TMDLs are protective of all designated uses. When the draft criteria for TN and TP become numeric standards they will be in DEQ’s DEQ-12 circular.

The nutrient target suite for streams in the Northern Rockies Level III Ecoregion also includes two biometric indicators: macroinvertebrates and diatoms. For macroinvertebrates, the Hilsenhoff Biotic Index (HBI) score) is used. The HBI value increases as the amount of pollution tolerant macroinvertebrates in a sample increases; the macroinvertebrate target is an HBI score equal to or less than 4.0 (Suplee and Sada de Suplee, 2011) (**Table 6-2**). Benthic diatoms, or periphyton, are a type of algae that grow on the stream bottom, and there are certain taxa that tend to increase as nutrient concentrations increase. The diatom target is a periphyton sample with a ≤51% probability of impairment by nutrients (Suplee and Sada de Suplee, 2011) (**Table 6-2**).

Because numeric nutrient chemistry is established to maintain algal levels below target chlorophyll-*a* concentrations and AFDM, target attainment applies and is evaluated during the summer growing season (July 1–September 30 for the Northern Rockies Level III Ecoregion) when algal growth will most likely affect beneficial uses. For data evaluation, samples collected ten days on either side of the growing season may also be included (Suplee and Watson, 2013). Targets listed here have been established specifically for nutrient TMDL development in the Kootenai-Fisher Project Area and may or may not be applicable to streams in other TMDL project areas.

Table 6-2. Nutrient Targets for the Kootenai-Fisher Project Area

Parameter	Northern Rockies Level III Ecoregion Target Value
Nitrate+Nitrite (NO_3+NO_2)(1)	≤ 0.10 mg/L
Total Nitrogen (TN)(2)	≤ 0.275 mg/L
Total Phosphorus (TP)(2)	≤ 0.025 mg/L
Chlorophyll-*a*(2)	≤ 125 mg/m2
Ash Free Dry Mass (AFDM)	≤ 35 g /m2
Hilsenhoff’s Biotic Index (HBI)(3)	< 4.0
Periphyton(3)	< 51%

(1) Value is from Suplee (11/14/2013)
(2) Value is from Suplee and Watson (2013).
(3) Value is from Suplee and Sada de Suplee (2011).

6.4.3 Existing Conditions and Comparison to Targets

To evaluate whether attainment of nutrient targets has been met, the existing water quality conditions in each waterbody segment are compared to the water quality targets in **Table 6-2** using the methodology in the DEQ draft guidance document "2011 Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels" (Suplee and Sada de Suplee, 2011). This approach provides DEQ with updated impairment determinations used for TMDL development. Because the original impairment listings are based on old data or were listed before developing the numeric criteria, each stream segment will be evaluated for impairment from nitrate, TN, and TP using data collected within the past 10 years. Additionally, nutrient samples collected prior to 2005 were analyzed for Total Kjehldahl Nitrogen (TKN), which has since been replaced by DEQ with Total Persulfate Nitrogen as the preferred analytical method for total nitrogen; samples analyzed for TKN may have a bias and are excluded from the data review.

The assessment methodology uses two statistical tests (Exact Binomial Test and the One-Sample Student's T-test for the Mean) to evaluate water quality data for compliance with established target values. In general, compliance with water quality targets is not attained when nutrient chemistry data shows a target exceedance rate of >20% (Exact Binomial Test), when mean water quality nutrient chemistry exceeds target values (Student T-test), or when a single chlorophyll-*a* value exceeds benthic algal target concentrations (125 mg/m^2 or 35 g AFDW/m^2). Where water chemistry and algae data do not provide a clear determination of impairment, or where other limitations exist, macroinvertebrate and periphyton biometrics are considered in further evaluating compliance with nutrient targets. Lastly, inherent to any impairment determination is the existence of human sources of pollutant loading. Human-caused sources of nutrients must be present for a stream to be considered impaired. To ensure a higher degree of certainty for removing an impairment determination and making any new impairment determination, the statistical tests are configured differently for an unlisted nutrient form than for a listed nutrient form. This can result in a different number of allowable exceedances for nutrients within a single stream segment. Such tests help assure that assessment reaches do not vacillate between listed and delisted status by the change in results from a single additional sample. When applying the T-test for assessment and sample values were below detection limits, one-half the detection limit was used.

As mentioned in **Section 6.2,** recent data from Bristow Creek showed no nutrient impairment and it will be delisted for TN on the 2014 303(d) List. It was assessed by DEQ following the same process outlined in this section, but because it does not need any nutrient TMDLs, the data are not presented within this section. Assessment information for Bristow Creek may be obtained by contacting DEQ. A summary of the existing data, comparison to water quality targets, and TMDL development determinations are presented for all other stream segments of concern. Because Stanley is within the Lake Creek watershed, they are discussed prior to Raven Creek.

6.4.3.1 Stanley Creek (MT76D002_010)

Stanley Creek is on the 2012 303(d) List as impaired for Nutrient/Eutrophication-Biological Indicators. The impaired segment of Stanley Creek begins at headwaters and flows 6.0 miles until the confluence with Lake Creek. It was originally listed in 2000 based on macroinvertebrate data indicating nutrient enrichment, but at the time the nutrient causing the impairment was unknown.

Summary nutrient data statistics and assessment method evaluation results for Stanley Creek are provided in **Tables 6-3 and 6-4**, respectively. Twenty-four NO_3+NO_2 samples were collected between

2003 and 2012; values ranged from 0.06 to 0.71 mg/L with six samples exceeding the NO_3+NO_2 target of 0.10 mg/L. Six TN samples were collected between 2011 and 2012; values ranged from < 0.1 to 0.11 mg/L with zero samples exceeding the TN target of 0.275 mg/L. Nineteen TP samples were collected between 2005 and 2012; values ranged from <0.003 to 0.04 mg/L with one sample exceeding the TP target of 0.025 mg/L.

Chlorophyll-*a* was visually estimated to be below 50 mg/m^2 at two sites in Stanley Creek in 2012. No samples were collected, and no AFDM data are available. There was one macroinvertebrate and one periphyton sample collected from Stanley Creek in 2011, and both samples met their respective target value.

Based on the assessment results (**Table 6-4)** Stanley Creek is impaired for NO_3+NO_2. The Nutrient/Eutrophication-Biological Indicators impairment cause will be refined to a NO_3+NO_2 impairment listing for the 2014 303(d) List and a nitrate + nitrite TMDL will be completed for Stanley Creek.

Table 6-3. Nutrient Data Summary for Stanley Creek

Nutrient Parameter	Sample Timeframe	Sample Size	Min[1]	Max	Median
NO_3+NO_2, mg/L	2003-2012	24	0.06	0.71	0.09
TN, mg/L	2011-2012	5	0.09	0.14	0.11
TP, mg/L	2005-2012	19	<0.003	0.04	0.006
Chlorophyll-*a*, mg/m^2	2012	2	<50[2]	<50[2]	<50[2]
AFDM, g/m^2	2011-2012	0	NA	NA	NA
Macroinvertebrate HBI	2011	1	2.90	2.90	2.90
Periphyton	2011	1	26.7%	26.7%	26.7%

[1] Values preceded by a "<" symbol are detection limits for that parameter. The actual sample value was below the detection limit.

[2] Visually estimated to be less than 50 mg/m2

Table 6-4. Assessment Method Evaluation Results for Stanley Creek

Nutrient	Sample Size	Target Value (mg/L)	Target Exceed-ances	Binomial Test Result	T-test Result	Chl-*a* Test Result	AFDM Test Result	Macro Test Result	Peri-phyton	TMDL Required ?
NO_3+NO_2	24	0.10	6	**FAIL**	**FAIL**	Pass	Pass	Pass	Pass	**YES**
TN	6	0.275	0	PASS	PASS					NO
TP	19	0.025	1	PASS	PASS					NO

6.4.3.2 Lake Creek (MT76D002_061)

Lake Creek is on the 2012 303(d) List as impaired for Nitrate/Nitrite (Nitrite + Nitrate as N). The impaired segment of Lake Creek begins at the outlet of Bull Lake and flows 17.6 miles to the confluence with the Kootenai River. Lake Creek was originally identified as impaired in 2000 based on nutrient, algal, and macroinvertebrate data collected near the Troy Mine.

Summary nutrient data statistics and assessment method evaluation results for Lake Creek are provided in **Tables 6-5 and 6-6**, respectively. Fifty-two NO_3+NO_2 samples were collected between 2003 and 2012; values ranged from 0.02 to 0.14 mg/L with 7 samples exceeding the NO_3+NO_2 target of 0.10 mg/L. Sixteen TN samples were collected between 2007 and 2012; values ranged from <0.01 to 0.12 mg/L with zero samples exceeding the TN target of 0.275 mg/L. Forty-six TP samples were collected between 2005 and 2012; values ranged from <0.005 to 0.016 mg/L with zero samples exceeding the TP target of 0.025 mg/L.

Eight chlorophyll-*a* and seven AFDM samples were collected from Lake Creek between 2011 and 2012. Chlorophyll-*a* values ranged from 5.5 to 38.9 mg/m^2 with none exceeding the target of 125 mg/m^2. The AFDM samples ranged from 18.5 to 69.5 g/m^2 with four of the observations exceeding the target of 35 g/m^2. There were two macroinvertebrate and two periphyton samples collected from Lake Creek in 2011, and all samples met their respective target value. The exceedance of the AFDM target indicates nutrient impairment. According to DEQ's assessment methodology, failure of biological targets while meeting the nutrient targets indicates algae may be taking up excess nutrients in the water column and/or that water quality sampling missed the pulse of nutrients to the system that is causing the biological response.

All nutrient forms passed both statistical tests, but NO_3+NO_2 was at the maximum number of allowable exceedances for the binomial test. Therefore, the assessment results (**Table 6-6)** support the existing Lake Creek impairment listing for NO_3+NO_2. Because the NO_3+NO_2 impairment is not associated with a TN impairment, only a nitrate + nitrite TMDL will be completed for Lake Creek.

Table 6-5. Nutrient Data Summary for Lake Creek

Nutrient Parameter	Sample Timeframe	Sample Size	Min[1]	Max	Median
NO_3+NO_2, mg/L	2003-2012	52	0.02	0.14	0.06
TN, mg/L	2007-2012	16	< 0.01	0.12	0.09
TP, mg/L	2005-2012	46	<0.005	0.016	0.006
Chlorophyll-*a*, mg/m^2	2011-2012	8	5.5	38.9	14.0
AFDM, g/m^2	2011-2012	7	13.5	69.5	37.3
Macroinvertebrate HBI	2011	2	3.42	3.64	3.53
Periphyton	2011	2	20.0%	29.1%	24.6%

[1] Values preceded by a "<" symbol are detection limits for that parameter. The actual sample value was below the detection limit.

Table 6-6. Assessment Method Evaluation Results for Lake Creek

Nutrient	Sample Size	Target Value (mg/l)	Target Exceed -ances	Binomial Test Result	T-test Result	Chl-*a* Test Result	AFDM Test Result	Macro Test Result	Peri-phyton	TMDL Required ?
NO_3+NO_2	52	0.10	7	Pass	Pass	Pass	**FAIL**	Pass	Pass	**YES**
TN	16	0.275	0	Pass	Pass					No
TP	46	0.025	0	Pass	Pass					No

6.4.3.3 Raven Creek

Raven Creek is on the 2012 303(d) List as impaired for total phosphorus, nitrate/nitrite, total nitrogen, and chlorophyll-*a*. The impaired segment of Raven Creek begins at headwaters and flows three miles until the confluence with Pleasant Valley Fisher River. Raven Creek was originally listed in 2006 based on nutrient and algal data.

Summary nutrient data statistics and assessment method evaluation results for Raven Creek are provided in **Tables 6-7 and 6-8**, respectively. Thirteen NO_3+NO_2 samples were collected between 2004 and 2013; values ranged from 0.01 to 0.04 mg/L with no samples exceeding the NO_3+NO_2 target of 0.10 mg/L. Twelve TN samples were collected between 2004 and 2013; values ranged from < 0.05 to 0.12 mg/L with zero samples exceeding the TN target of 0.275 mg/L. Thirteen TP samples were collected between 2004 and 2013; values ranged from <0.012 to 0.055 mg/L with two samples exceeding the TP target of 0.025 mg/L.

Five chlorophyll-*a* and three AFDM samples were collected between 2011 and 2012. Chlorophyll-*a* values ranged from 7.7 to 22.4 mg/m^2 with none exceeding the target of 125 mg/m^2. Similarly, AFDM samples were all below the target of 35 g/m^2. There were four macroinvertebrate samples collected from Raven Creek and all of the values were less than the HBI target of 4.0. Two periphyton samples were collected in 2013 and both were well above the target of 51%.

The failure of the binomial test for TP combined with the exceedance of the periphyton target (**Table 6-8**) supports the existing Raven Creek impairment listing for TP. However, assessment results (**Table 6-8**) indicate that Raven Creek is not impaired for NO_3+NO_2, TN, or chlorophyll-*a* and those causes will be delisted on the 2014 303(d) List. A TP TMDL will be completed for Raven Creek.

Table 6-7. Nutrient Data Summary for Raven Creek

Nutrient Parameter	Sample Timeframe	Sample Size	Min[1]	Max	Median
NO_3+NO_2, mg/L	2004-2013	13	0.01	0.04	0.02
TN, mg/L	2004-2013	12	<0.05	0.12	0.06
TP, mg/L	2004-2013	13	<0.012	0.055	0.018
Chlorophyll-*a*, mg/m^2	2011, 2012	5	7.7	22.4	<20
AFDW, g/m^2	2011, 2012	3	4.27	6.49	5.79
Macroinvertebrate HBI	2005, 2010, 2011	4	2.45	3.96	3.75
Periphyton (%)	2013	2	70.5	72.1	71.3

[1] Values preceded by a "<" symbol are detection limits for that parameter. The actual sample value was below the detection limit.

Table 6-8. Assessment Method Evaluation Results for Raven Creek

Nutrient Parameter	Sample Size	Target Value (mg/l)	Target Exceedances	Binomial Test Result	T-test Result	Chl-*a* Test Result	AFDM Test Result	Macro Test Result	Peri-phyton	TMDL Required ?
NO_3+NO_2	13	0.1	0	PASS	PASS	Pass	Pass	Pass	**FAIL**	No
TN	12	0.275	0	PASS	PASS					No
TP	13	0.025	2	**FAIL**	PASS					**YES**

6.4.4 Nutrient TMDL Development Summary

Based on the assessment results, three nutrient TMDLs will be developed as summarized in **Table 6-9**.

Table 6-9. Nutrient TMDL Summary for the Kootenai-Fisher Project Area

Stream Segment	Waterbody ID	TMDL
LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)	MT76D002_070	Nitrate/Nitrite
RAVEN CREEK, headwaters to mouth (Pleasant Valley Fisher River)	MT76C001_030	Total Phosphorus
STANLEY CREEK, Headwaters to the mouth	MT76D002_010	Nitrate/Nitrite

6.5 SOURCE ASSESSMENTS, TMDLS, AND ALLOCATIONS

This section summarizes the approach used for the source assessment, TMDLs, and allocations, and then presents the source assessment results, TMDL, allocations, and estimated reductions necessary to meet water quality targets for each nutrient impaired stream.

6.5.1 Source Assessment Approach

Source characterization was conducted by using aerial photos, GIS analysis, field work, phone interviews, and literature reviews to determine the major sources in each of the nutrient impaired watersheds. There are no permitted point sources in the three watersheds. Therefore, nutrient loading is coming from two source types: 1) natural sources derived from airborne deposition, vegetation, soils, and geologic weathering; and 2) human-caused nonpoint sources dispersed across the landscape (e.g., mining, septic, residential development, and timber harvest).

Because of human sources in the headwaters of all three nutrient impaired streams in the project area and intermittent flow in the upper watershed of Stanley and Raven creeks, no monitoring data could be used to estimate natural background nutrient loading. Natural background loading was estimated by using the median concentration from the reference nutrient dataset for each pollutant in the Level III Northern Rockies ecoregion (as described in Suplee and Watson, 2013; Suplee et al., 2008): NO_3+NO_2 = 0.009 and TP = 0.005 mg/L. A simple mass balance approach was used to quantify the load from human sources. Monitoring data collected in the project area from 2003 through 2013 were analyzed to determine existing loads at various locations throughout the impaired streams. Box plots, line graphs, and other statistical analyses helped to define the magnitude and location of nutrient loading.

6.5.2 TMDL and Allocation Summary

Nutrient TMDLs will be developed for the nutrient causes identified for each waterbody in **Table 6-9**. Because streamflow varies seasonally, TMDLs are not expressed as a static value, but as an equation of the appropriate target multiplied by flow as shown in **Equation 6-1**. As flow increases, the allowable load (TMDL) increases as shown by the nitrate TMDL example in **Figure 6-2.** Like the water quality targets, the TMDLs are applied only to the summer growing season (July 1st through Sept 30th). For each stream, a TMDL example is presented based on measured flows and the highest growing season concentration , but the range of reductions necessary based on all growing season sampling data is also discussed.

Equation 6-1*: TMDL (lbs/day) = (X) (Y) (k)*

X = water quality target in mg/L (NO_3+NO_2 = 0.1 mg/L, TP = 0.025 mg/L)
Y = streamflow in cubic feet per second (cfs)
k = conversion factor of 5.4

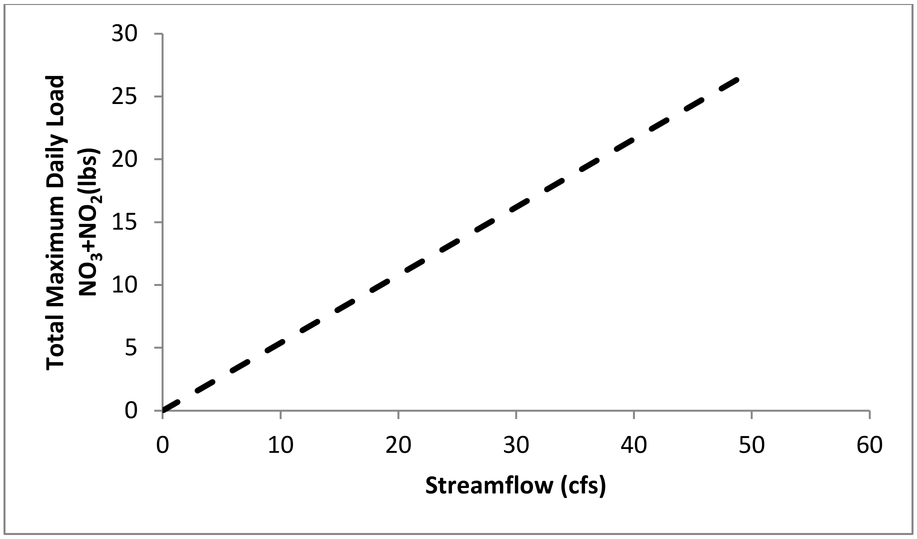

Figure 6-2. Example TMDL for NO_3+NO_2 for streamflow ranging from 0 to 50 cfs

Because a simple approach was used for the source assessment and all sources are nonpoint, the TMDL allocations for each stream are broken into a load allocation to natural background and a composite load allocation to all human-caused nonpoint sources. Therefore, the equation for all nutrient TMDLs is as follows:

$$\textbf{TMDL} = \textbf{LA}_{\text{Natural Background}} + \textbf{LA}_{\text{Human Sources}}$$

The LA $_{\text{Human Sources}}$ is calculated by subtracting the LA $_{\text{Natural Background}}$ from the TMDL. Because there are no point sources, the wasteload allocation (WLA) is 0. All nutrient TMDLs include an implicit margin of safety (MOS), which is based on conservative assumptions as described in **Section 6.6.2**.

6.5.2.1 Meeting Allocations

Allocations are intended to be met by implementation of additional BMPs. It is important to recognize that the first critical step toward meeting the nutrient allocations involves applying and/or maintaining the land management practices or BMPs that will reduce nutrient loading. Once these actions have been completed at a given location, the landowner or land manager will have taken action consistent with the intent of the nutrient allocation for that location. For many nonpoint source activities, it can take several years to achieve the full load reduction at the location of concern, even though full BMP implementation is in effect. For example, it may take several years for riparian areas to fully recover and decrease nutrient loading after implementing grazing BMPs. It is also important to apply proper BMPs and other water quality protection practices for all new or changing land management activities to limit any potential increased nutrient loading.

Progress towards TMDL and individual allocation achievement can be gauged by BMP implementation and improvement in or attainment of water quality targets defined in **Section 6.4.2**. Any effort to calculate loads and percent reductions for purposes of comparison to TMDLs and allocations in this document should be accomplished via the same methodology used to develop the loads and percent reductions presented within this document.

6.5.3 Stanley Creek

6.5.3.1 Assessment of Water Quality Results

Nitrate/nitrite concentrations in Stanley Creek between 2003 and 2012 were relatively consistent over time (**Figure 6-3**), with a median value of 0.09 mg/L. There were a few very high values in 2005 but overall there does not appear to be an increasing or decreasing trend over time. Available flow data were also assessed relative to target exceedances and there were no flow-related patterns. However, when looking at box plots of individual monitoring sites over the same time period (**Figure 6-4**), NO_3+NO_2 concentrations are higher in the upstream reaches and noticeably decrease at the mouth (**Figure 6-5**).

Stanley Creek receives most of its flow from Fairway Creek and is usually intermittent upstream of the confluence during summer months. Stanley Creek upstream of Fairway Creek had zero flow during several site visits in 2012. There are four sets of synoptic samples (i.e., collected on the same day) for sites upstream and downstream of Fairway Creek which can be used to help with the source assessment. NO_3+NO_2 concentrations at the site just downstream of Fairway Creek (K01STNLC01/SC02) are typically close to those upstream of Fairway Creek, as evidenced by the median at that site and the upper site (K01STNLC05/SC15) being similar (**Figure 6-4**). Particularly given the substantial flow from Fairway Creek, this indicates Fairway Creek is also a source of NO_3+NO_2 to Stanley Creek. Fairway Creek originates from Spar Springs (which are fed by Spar Lake in the upper watershed) approximately 0.5 miles upstream of its confluence with Stanley Creek (KNF 2010).

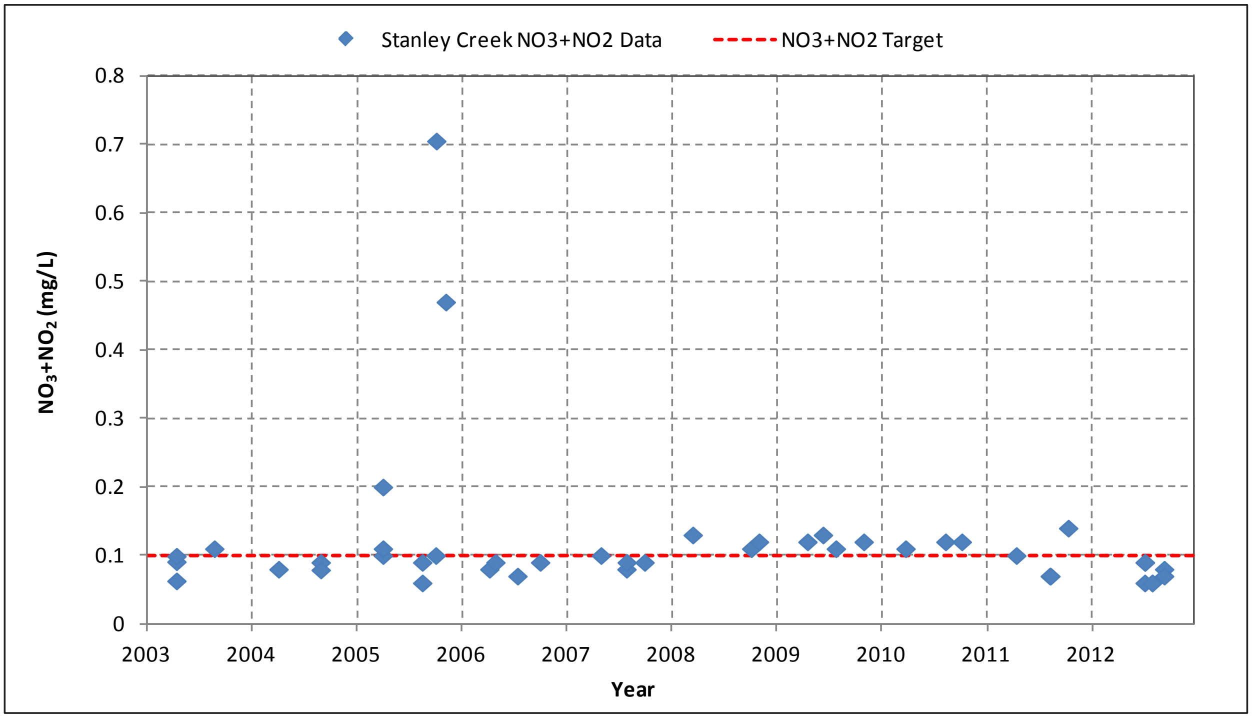

Figure 6-3. NO_3+NO_2 data collected in Stanley Creek, 2003-2012

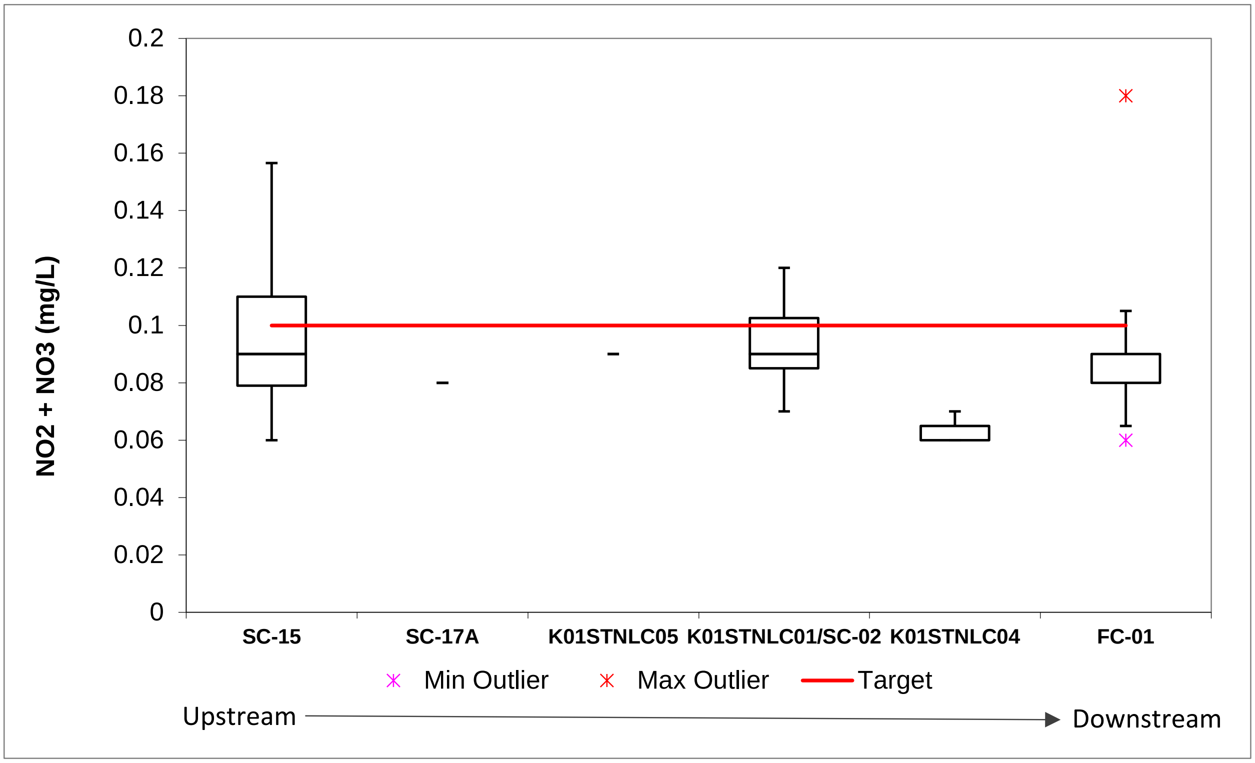

Figure 6-4. NO_3+NO_2 box plots for monitoring sites on Stanley Creek and Fairway Creek (FC-01), 2003-2012, growing season only

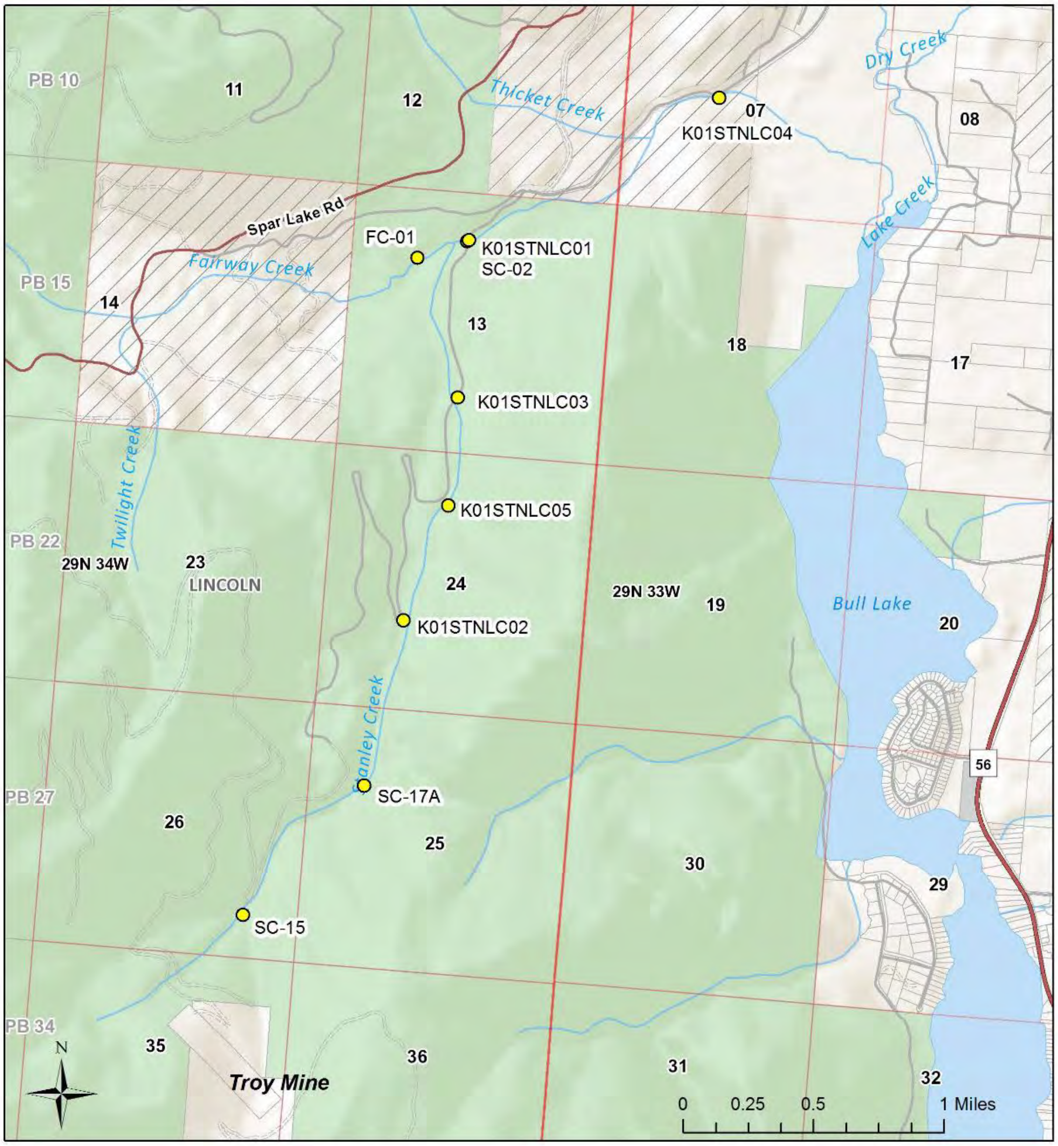

Figure 6-5. Location of the Stanley Creek monitoring stations

6.5.3.2 Source Assessment

The Stanley Creek watershed is located within the upper Lake Creek watershed just west of Bull Lake, and although it is primarily on land administered by the KNF, the Troy Mine is located near its headwaters (**Figure 6-5**). The predominant human sources that could contribute NO_3+NO_2 to Stanley Creek are timber harvest and mining. Each of the potential human sources is discussed below, followed by an analysis of the sources.

Timber Harvest

Timber harvest has the potential to affect nitrate loading because it can affect water yield and peak flows and also because it affects biological uptake and nutrient cycling in the soil. Timber harvest has long been a land use in the watershed, but since nutrient concentrations tend to return to normal within two to three years post-harvest (Feller and Kimmins, 1984; Likens et al., 1978; Martin and Harr, 1989), the assessment of the potential for harvest-related NO_3+NO_2 loading focused on recent harvest activity.

The KNF harvested timber above the headwaters near Spar Lake in 2004/2005 via helicopter. The Stimson Lumber Company selectively harvested from 129 acres in the Fairway Creek subdrainage in 2012 (USDA Forest Service, Kootenai National Forest (KNF), 2012). Timber harvest related to the Sparring Bulls timber harvest project was initiated in 2013 and will likely continue until 2015. Harvest will also be occurring in the watershed from 2013-2015 (Newgard, Kris, personal communication 3/20/2014; USDA Forest Service, Kootenai National Forest (KNF), 2012). Although the sampling conducted to support TMDL development does not overlap with the Sparring Bulls harvest, environmental analysis conducted by the KNF as part of the Sparring Bulls Final Environmental Impact Statement (EIS) concluded the project would not result in elevated nutrient concentrations in Stanley Creek because of the location and intensity of the harvest, and that the Stimson project activities would also not harm beneficial uses (USDA Forest Service, Kootenai National Forest (KNF), 2012).

Mining

Mining could be a source of NO_3+NO to Stanley Creek because it is a byproduct of explosives used during mining. With the exception of a closure between 1993 and 2004 because of metals prices and since December 2012 because of rock falls and haul route instability, Troy Mine has been active since the early 1970s (U.S. Forest Service and Montana Department of Environmental Quality, 2012; Associated Press, 10/19/2013). The mill and associated facilities, portals, and ventilation adits for Troy Mine are all in the upper Stanley Creek watershed. The creek flows just east of the mill site, which is at the entrance to the mine (USDA Forest Service, Kootenai National Forest (KNF), 2010). Although the mine does not have any direct discharges to surface water, NO_3+NO_2 from blasting could enter Stanley Creek through fractures in the bedrock in the mine void. This loading pathway as well as evidence of elevated NO_3+NO_2 concentrations in mine water are documented in the Final EIS for the Troy Mine Revised Reclamation Plan (U.S. Forest Service and Montana Department of Environmental Quality, 2012): “Nutrients, including ammonia and nitrate plus nitrite, are elevated in mine water due to residues from blasting compounds…although most water from the mine void is removed by pumping, some of it may re-enter the groundwater system, ultimately discharging to streams, seeps and springs, and to groundwater aquifers in the Stanley Creek and Ross Creek watersheds” (U.S. Forest Service and Montana Department of Environmental Quality, 2012). According to the EIS, nitrate concentrations in mine discharge water ranged from 0.7 to 13.6 mg/L, with a mean concentration of 4.88 mg/L during active mining operations from 2004-2009 (U.S. Forest Service and Montana Department of Environmental Quality, 2012).

Loading Analysis

Based on the known elevated levels of NO_3+NO_2 in mine water, fractured bedrock in upper Stanley Creek, and target exceedances in upper Stanley Creek, loading via groundwater from the mine void at Troy Mine appears to be the dominant human source of NO_3+NO_2 to upper Stanley Creek (i.e., headwaters to the confluence with Fairway Creek). Limited sampling data of headwater tributaries of Stanley Creek validate this conclusion but also indicate natural background concentrations may be contributing to the observed nitrate exceedances. Additional investigation and monitoring is recommended to refine the source assessment for upper Stanley Creek. The upper segment of Stanley Creek is often intermittent in the summer, and paired flow-nitrate data show that this segment contributes a relatively small nitrate load to the lower segment. However, due to the target exceedances observed in this segment, load reductions are still required.

Fairway Creek is a major tributary to Stanley Creek, with an average measured flow of 66 cfs (Troy Mine Data, 1985-2009). Although upper Stanley Creek tends to have higher and more frequent spikes in nitrate concentrations, Fairway Creek also has high nitrate values at times (**Figure 6-6**). Particularly given the average flow in Fairway Creek, its input dominates the nitrate load downstream of its confluence with Stanley Creek. It does not appear that the Troy Mine is directly having an impact on Fairway Creek nitrate concentrations, as there are no known fractures or faults draining from the Troy Mine vicinity to Fairway Creek (Jepson, Wayne, personal communication 11/20/2013). Other potential anthropogenic nitrate sources in Fairway Creek include timber harvest, the campground at Spar Lake, and abandoned mines. Given that the campground has light usage and toilet waste that has been contained in concrete vaults for over 20 years (Newgard, Kris, personal communication 12/2/2013) it is unlikely that it is a source of nitrate to Fairway Creek. It is possible that there are unknown human sources in Fairway Creek, or that the Fairway Creek watershed has a naturally high nitrate load. Future monitoring is recommended in this watershed to better define sources.

Downstream of the confluence with Fairway Creek, Stanley Creek is largely comprised of flow from Fairway Creek in the summer months. Potential sources in this portion of the watershed (i.e., confluence to the mouth) include timber harvest and upstream sources.

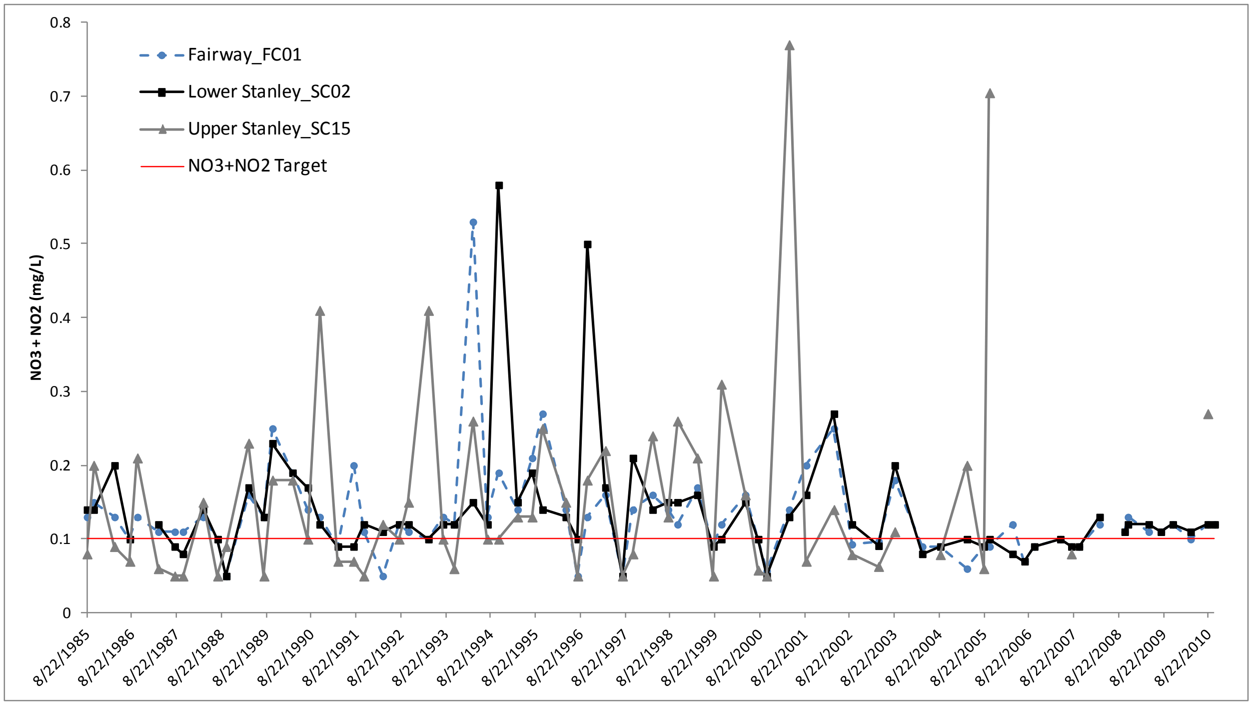

Figure 6-6. Long-term NO_3+NO_2 concentrations for upper and lower Stanley Creek and Fairway Creek

6.5.3.3 Nitrate/Nitrite TMDL, Allocations, Current Loading, and Reductions

Based on the monitoring data, NO_3+NO_2 load reductions between 0% and 86% are required. In other words, the NO_3+NO_2 concentration in the creek is sometimes below the target concentration, and no load reduction is required. At its worse, the NO_3+NO_2 concentration (and associated load) needs to be reduced by 86%. Of the 22 available growing season samples in Stanley Creek, only six of them exceed the NO_3+NO_2 target, which suggests that only minor changes in management activities are needed to meet the TMDL and water quality standard.

Because of the uncertainty regarding human caused sources other than mining, the TMDL will be composed of two load allocations: one to natural background sources and the other to all human sources (e.g., mining, timber harvest, etc.). The largest load reductions are required in the upper portion of Stanley Creek. **Table 6-10** shows an example NO_3+NO_2 TMDL for upper Stanley Creek (headwaters to the confluence with Fairway Creek). The example is presented for the worst case measured conditions in the creek during the growing season. A second TMDL example is presented for lower Stanley Creek (confluence with Fairway Creek to the mouth) (**Table 6-11**). Although examination of best management practices to reduce nitrate concentrations in mine wastewaters should be evaluated to determine if improvements can be made, particularly given the loading from Fairway creek and uncertainty regarding sources in that drainage, additional monitoring and refinement of the source assessment is recommended to better identify source loadings from both segments of the creek and the source of non-mining related loading.

Table 6-10. Example NO_3+NO_2 TMDL for Stanley Creek, headwaters to the confluence with Fairway Creek

Allocation	Source Category	Current Load (lbs/day)[1]	% Reduction	Allocation (lbs/day)	Rationale/Assumptions
Load Allocation	Natural Background	0.02	0%	0.02	Assumes a natural background concentration of 0.009 mg/L NO_3+NO_2 and a flow of 0.32 cfs measured at site SC15.
	Mining, Timber Harvest, & Other Human Sources	1.20	88%	0.15	Activities at the Troy Mine are the likely source of nitrate loading to this segment of Stanley Creek
TMDL	All Sources	1.22[1]	86%	0.17	

[1] Based on a measured concentration of 0.705 mg/L and an estimated flow of 0.32 cfs on October 7, 2005 at site SC15

Table 6-11. Example NO_3+NO_2 TMDL for Stanley Creek, confluence with Fairway Creek to the mouth.

Allocation	Source Category	Current Load (lbs/day)	% Reduction	Allocation (lbs/day)	Rationale/Assumptions
Load Allocation	Natural Background	3.61	0%	3.61	Assumes a natural background concentration of 0.009 mg/L NO_3+NO_2 and a flow of 74.32 cfs measured at site SC02.
	Mining, Timber Harvest, & Other Human Sources	76.51	52%	36.45	Fairway Creek is the major source of nitrate loading in this segment of Stanley Creek. Future work is needed to better define the anthropogenic source loads from Fairway Creek.
TMDL	All Sources	80.12[1]	50%	40.06	

[1] Based on a measured concentration of 0.20 mg/L and an estimated flow of 74.32 cfs on August 25, 2003 at site SC02

6.5.4 Lake Creek

6.5.4.1 Assessment of Water Quality Results

Figure 6-7 shows box plots of NO_3+NO_2 concentrations at selected stations on Lake Creek during the growing season, 2003-2012. **Figure 6-8** shows available synoptic NO_3+NO_2 data for Lake Creek. Both figures show that NO_3+NO_2 concentrations in the upstream portion of Lake Creek (i.e., just downstream of Bull Lake) are usually lower than the target. The data indicate there is a significant source of NO_3+NO_2 in the two mile segment between stations K01LAKEC06 and LC04 (river mile 12.5 to 10.1). This is located downstream of the Troy Mine Tailings Impoundment (**Figure 6-9**). By river mile 7.4 (Station K01LAKEC02), NO_3+NO_2 concentrations decrease to below the target concentration, and then continue to decrease moving downstream. This is likely somewhat associated with NO_3+NO_2 uptake by primary producers but also appears to be caused by dilution coming from tributaries such as Keeler Creek, Iron Creek, Copper Creek, etc. There were only three recent growing season sampling events that included synoptic samples down to the mouth of Lake Creek, and there was no trend in NO_3+NO_2 concentrations in lower Lake Creek: they increased slightly, decreased slightly, or stayed the same.

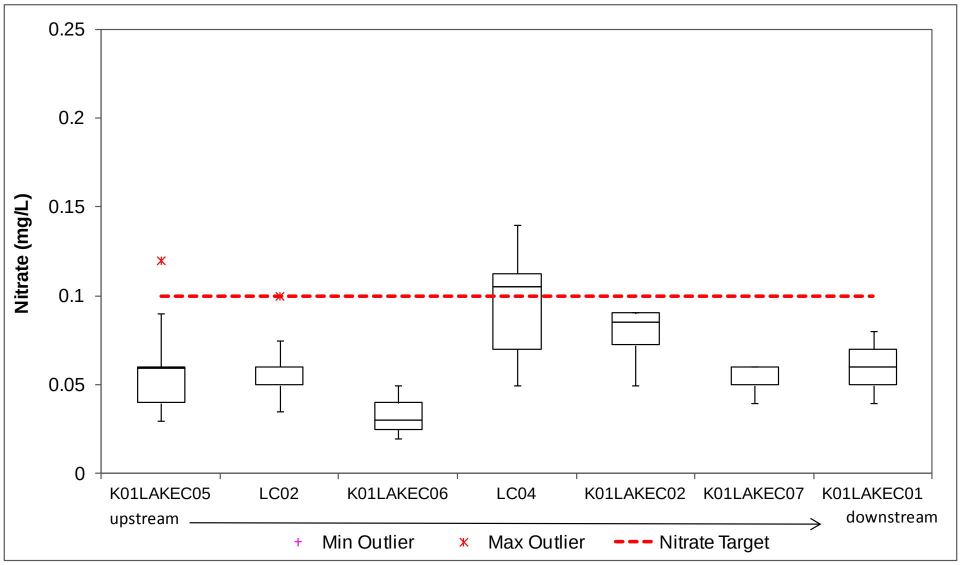

Figure 6-7. Nitrate/nitrite box plots for monitoring sites on Lake Creek, 2003-2012, growing season only[1]

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[1] Some sites in the above figures are collocated including: K01LAKEC05 (LKC-280 and LC01); K01LAKEC06 (LKCA); K01LAKEC02 (LKC-279,); K01LAKEC07 (LKC-278); and K01LAKEC01 (LKC-276).

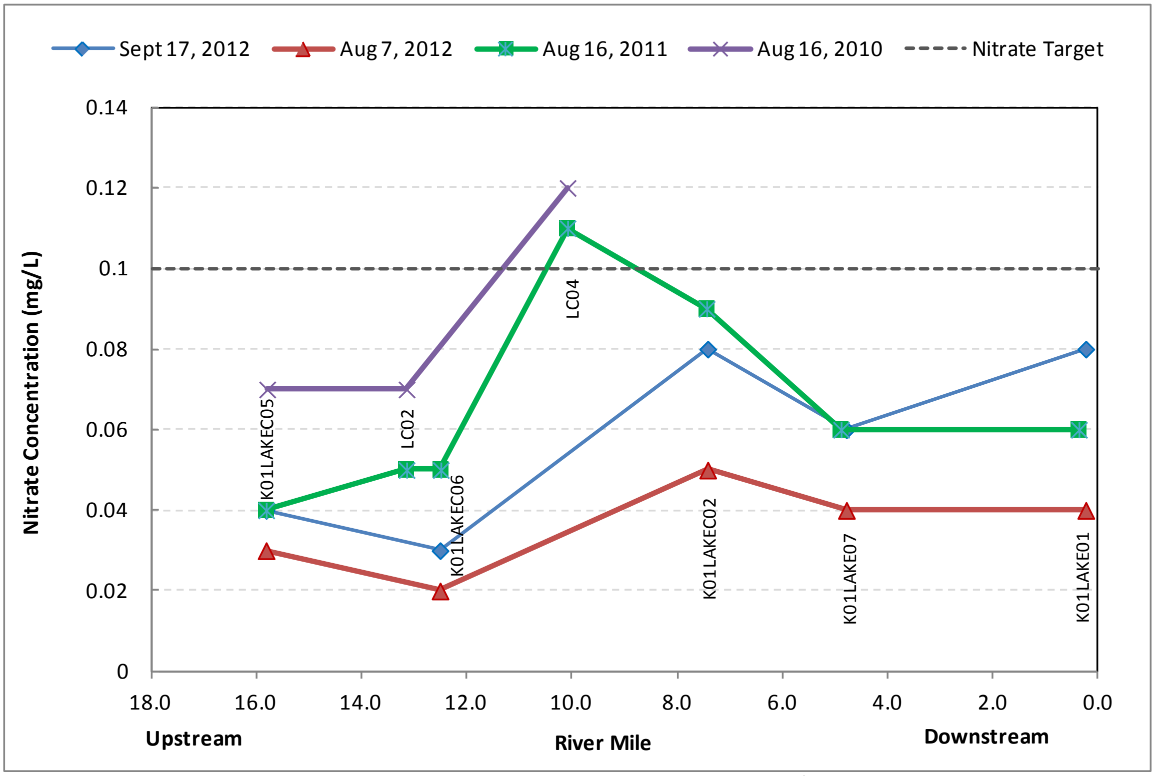

Figure 6-8. Synoptic growing season NO_3+NO_2 data for Lake Creek[1]

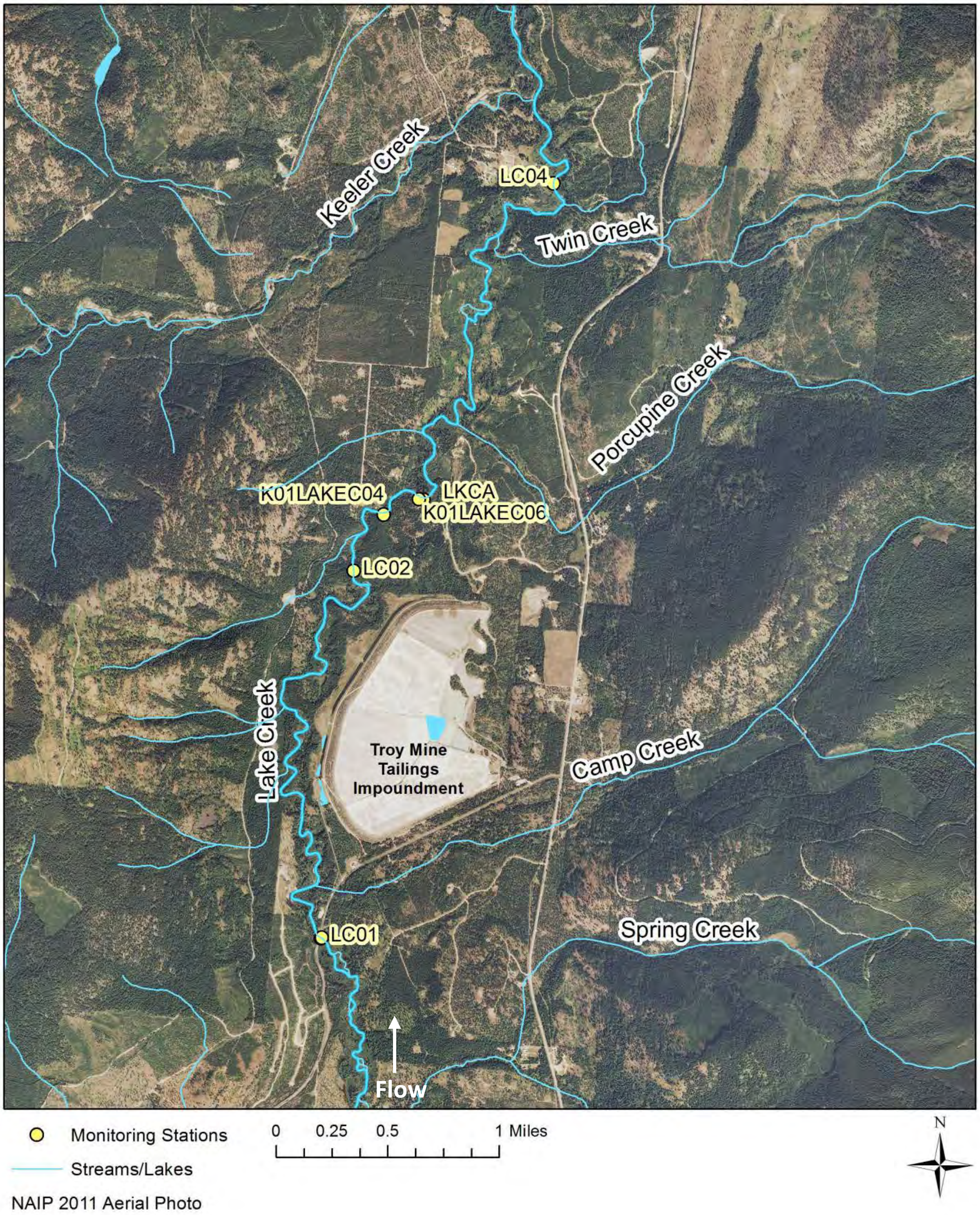

Figure 6-9. Location of monitoring sites on Lake Creek

6.5.4.2 Source Assessment

Lake Creek flows 17.6 miles from its headwaters at the outlet of Bull Lake to its mouth at the Kootenai River. There is some private development along Bull Lake and most of the riparian corridor is privately owned, but approximately 80% of the watershed is managed by the USFS (**Figure 5-2**). Potential human sources of NO_3+NO_2 in the Lake Creek watershed include mining, septic systems, and timber harvest. Each of the potential human sources is discussed below.

Mining
As described in **Section 6.6.1**, Stanley Creek is a tributary to Lake Creek, and at times contributes excess NO_3+NO_2 into Lake Creek. However, because NO_3+NO_2 concentrations are typically lower than the target at the mouth of Stanley Creek, and NO_3+NO_2 is bioavailable and tends to be consumed by primary producers quickly (Suplee, Michael W., personal communication 11/14/2013), concentrations in Lake Creek just downstream of the confluence with Stanley Creek (e.g., Stations K01LAKEC05 and LC02) rarely exceed the NO_3+NO_2 target.

In addition to Stanley Creek, the Troy Mine is partially located in the Ross Creek, Weasel Gulch, and Emma Gulch watersheds (tributaries to Bull Lake). The Troy Mine Revised Reclamation Plan Final Environmental Impact Statement states that most of the groundwater from the underground mines is pumped out and routed to the tailings pond downstream of Bull Lake. However, some of the groundwater from the mines potentially resurfaces in springs and seeps in the Ross Creek, Emma Gulch, and Weasel Gulch watersheds (tributaries to Bull Lake) (U.S. Forest Service and Montana Department of Environmental Quality, 2012). Data from Weasel Gulch and Emma Gulch do not currently exceed nitrate targets, but the limited data for Ross Creek suggests significant nitrate loadings (U.S. Forest Service and Montana Department of Environmental Quality, 2012).

Although there is no direct discharge to surface water, previous studies conclude that the Troy Mine Tailings Impoundment is a source of NO_3+NO_2 to groundwater in the Lake Creek watershed (U.S. Forest Service and Montana Department of Environmental Quality, 2012). The Final EIS for the Troy Mine Revised Reclamation Plan shows that groundwater nitrate concentrations in the vicinity of the tailings impoundment range from <0.01 to 1.19 mg/L (U.S. Forest Service and Montana Department of Environmental Quality, 2012). Mean nitrate concentrations in wells MW1 and MW95-4 (0.16 and 0.19 mg/L, respectively) are higher than the NO_3+NO_2 target of 0.10 mg/L. The Final EIS acknowledges that the tailings impoundment and toe ponds contribute excess nitrate to groundwater, and that a sump and pump system has been installed in the toe ponds to help mitigate nitrate concentrations (U.S. Forest Service and Montana Department of Environmental Quality, 2012).

Measured data show that nitrate concentrations in Lake Creek are regularly higher downstream of the tailings impoundment, which is where most of the target exceedances occurred. Because this trend has persisted for the past decade, and well before that (based on Troy Mine monitoring data), excess nitrate loading to the groundwater from the impoundment is well documented (U.S. Forest Service and Montana Department of Environmental Quality, 2012), and groundwater tends to flow towards Lake Creek (U.S. Forest Service and Montana Department of Environmental Quality, 2012), the pattern of elevated nitrate concentrations downstream of the impoundment are likely associated with groundwater loading from the impoundment. However, multiple tributaries (e.g., Camp Creek and Porcupine Creek) also flow into Lake Creek in this vicinity and may also be contributing to the nitrate load as well. Additionally, groundwater well data collected prior to the construction of the tailings impoundment show variable nitrate concentrations in the Lake Creek valley (Levings et al., 1984), and the cause of that and the relationship to concentrations today is uncertain. Future additional monitoring should be conducted to (1) determine the groundwater flow path and extent of nitrate loading from the tailings impoundment to Lake Creek, and (2) determine the nitrate contribution from any other localized sources, and (3) determine natural background levels of nitrate in localized groundwater.

Septic Systems

Septic systems, even when operating as designed can contribute nutrients to surface water through subsurface pathways. The amount of nutrients that a given septic system contributes to a waterbody is dependent upon its discharge, soils, and distance from the waterbody. The number and location of septic systems in the Lake Creek watershed was determined by downloading the Montana Structures Framework GIS layer (Montana State Library, 2012). The data layer indicates that there are approximately 585 structures in the watershed that potentially have septic systems. Most of the systems are located along the Lake Creek valley bottom, around Bull Lake, and in the Falls Creek watershed (**Figure 6-10**). There may be some localized excess loading from failing septic systems, but based on the low NO_3+NO_2 concentrations coming out of Bull Lake and near the mouth, where most of the septic systems are concentrated, NO_3+NO_2 loading to Lake Creek from septic systems is likely minimal.

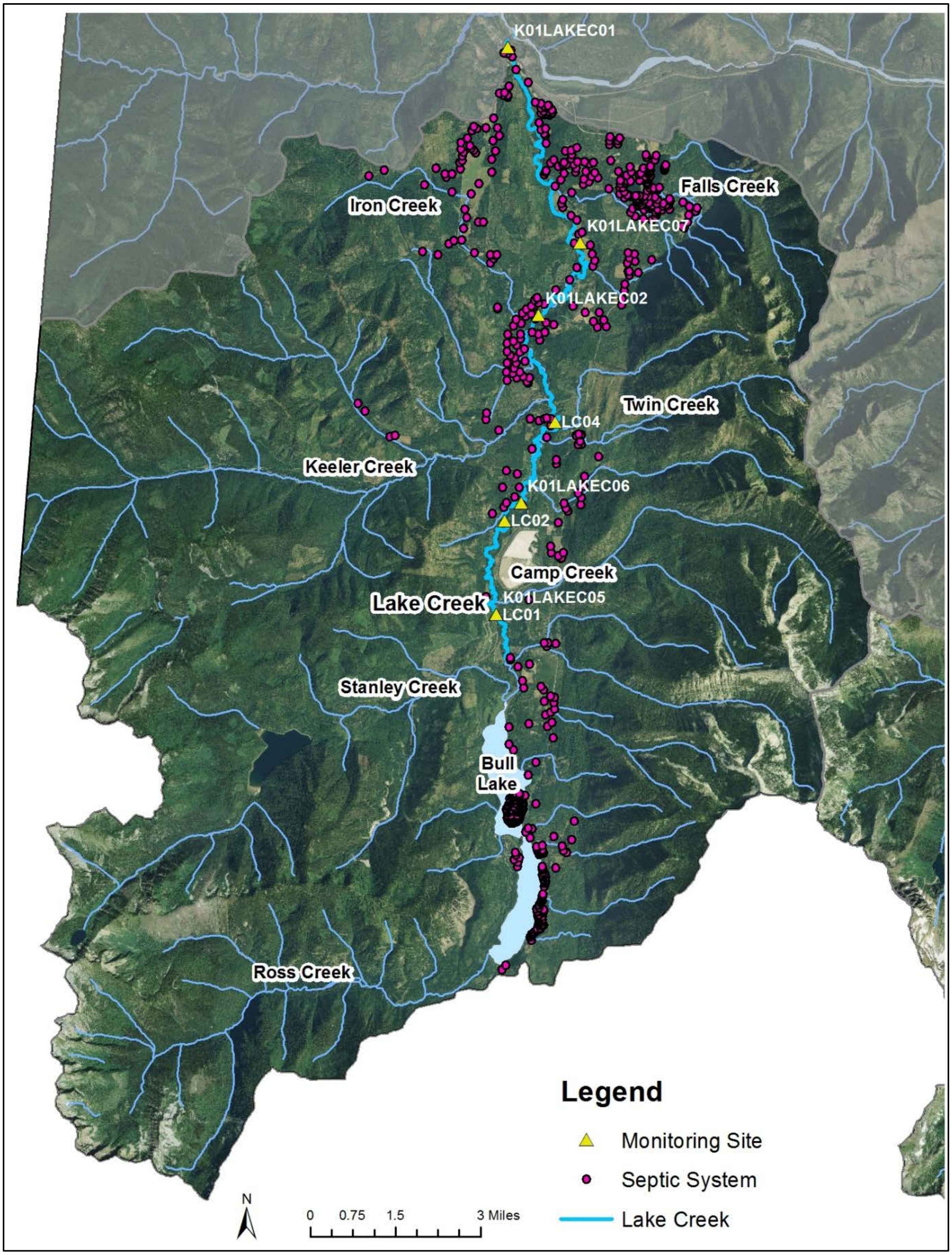

Figure 6-10. Distribution of septic systems in the Lake Creek watershed

Timber Harvest

Timber harvest has the potential to affect nitrate loading because it can affect water yield and peak flows and also because it affects biological uptake and nutrient cycling in the soil. Timber harvest is pervasive throughout the Lake Creek watershed, but since nutrient concentrations tend to return to normal within two to three years post-harvest (Feller and Kimmins, 1984; Likens et al., 1978; Martin and Harr, 1989), the assessment of the potential for harvest-related NO_3+NO_2 loading focused on recent harvest activity. As discussed in the source assessment for Stanley Creek (**Section 6.5.3.2**), some timber harvest occurred in the Stanley Creek watershed. However, no large scale timber harvest is known to have occurred in the Lake Creek watershed during the past several years when monitoring was being conducted to support TMDL development. The most recent harvests occurred in 2013 as part of the Sparring Bulls Timber Sale, which is ongoing through 2015.

Since 1994, riparian harvest has been limited or absent because the KNF has Riparian Habitat Conservation Areas that restrict harvest related activities on USFS land from a minimum of 50 to a minimum of 300 feet from streams and wetlands (distance is dependent on the waterbody type) and the Streamside Management Zone law that restricts commercial harvest-related activities by all landowners within 50 feet of streams. Based on the restrictions placed on riparian harvest, BMPs used during timber harvest, and the rapid decline in harvest-related nutrient loading following harvest activities, timber harvest is likely a minimal source of NO_3+NO_2 to Lake Creek.

6.5.4.3 Nitrate/Nitrite TMDL, Allocations, Current Loading, and Reductions

Based on the measured growing season concentrations, NO_3+NO_2 load reductions between 0% and 28% are required. In other words, NO_3+NO_2 concentrations in the creek are sometimes below the target concentration, and no load reduction is required. At its worse, the NO_3+NO_2 concentration (and associated load) needs to be reduced by 28%. Of the 52 available growing season samples in Lake Creek, only seven of them exceed the NO_3+NO_2 target, which suggests that only minor changes in management activities are needed to meet the TMDL and water quality standard. The largest load reductions are required near monitoring site LC04 and just downstream of the tailings impoundment. Based on monitoring data near the mouth, little to no reduction in NO_3+NO_2 loads are necessary downstream of site LC04 (near Twin Creek) to the mouth.

The TMDL will be composed of two load allocations: one to natural background sources and the other to all human sources (e.g., mining, timber harvest, septic systems, etc.). The largest load reductions are required near monitoring site LC04 (just downstream of the tailings impoundment and near the confluence with Twin Creek). **Table 6-11** shows an example NO_3+NO_2 TMDL with allocations based on sample data for Lake Creek. The example TMDL is presented for the worst case measured condition during the growing season. Although the source assessment indicates the tailings impoundment is the likely source of nitrate in the portion of Lake Creek needing the largest load reductions, target exceedances were sporadic and typically not much above the target value. Although examination of best management practices to reduce nitrate concentrations in mine wastewater should be evaluated to determine if improvements can be made, additional monitoring and refinement of the source assessment and loading pathways is also recommended.

Table 6-11. Example NO_3+NO_2 TMDL and allocations for Lake Creek

Allocation	Source Category	Current Load (lbs/day)	% Reduction	Allocation (lbs/day)	Rationale/Assumptions
Load Allocation	Natural Background	4.0	0%	4.0	Assumes a natural background concentration of 0.009 mg/L NO_3+NO_2 and a flow of 81.4 cfs measured at site LC04
	Mining, harvest, septics, and other human caused sources	57.5	30%	40.0	The existing load was calculated by subtracting the natural background load and the load from the impoundment from the existing calculated load.
	Troy Mine Tailings Impoundment	40.8	43%	23.3	The Troy Mine tailings impoundment is the major source of nitrate in Lake Creek. The existing load from the tailings impoundment was calculated based on the average increase in load from 8 synoptic samples collected at sites LC02 and LC04. This assumes that the loading increase between these two sites is solely due to the impoundment.
TMDL	**All Sources**	**61.5**[1]	**28%**	**44.0**	

[1] Based on a measured concentration of 0.14 mg/L and a measured flow of 81.4 cfs on August 19, 2005 at site LC04

6.5.5 Raven Creek

6.5.5.1 Assessment of Water Quality Results

Figure 6-11 shows the available TP data for Raven Creek from 2004-2013 (all stations). Overall, the data are limited and do not show any increasing or decreasing trends in time. **Figure 6-12** shows box plots of TP concentrations (growing season only) on Raven Creek, 2004-2013. There does not appear to be a strong trend in the data moving upstream to downstream **(Figure 6-13** shows station locations**)**. The 2004 sample was collected in the rain and the total suspended sediment concentration was 7mg/L – all other suspended sediment concentrations were close to or below the detection limit (i.e., 4 or 1 mg/L), indicating the elevated TP concentration in 2004 may be associated with sediment. However, there was no precipitation and the suspended sediment concentration was <1mg/L for the sample that exceeded the TP target in 2013. Both target exceedances occurred in the lower watershed upstream of Highway 2. It should be noted that upper Raven Creek typically has no surface flow, and it had no flow during several site visits in 2011 and 2012.

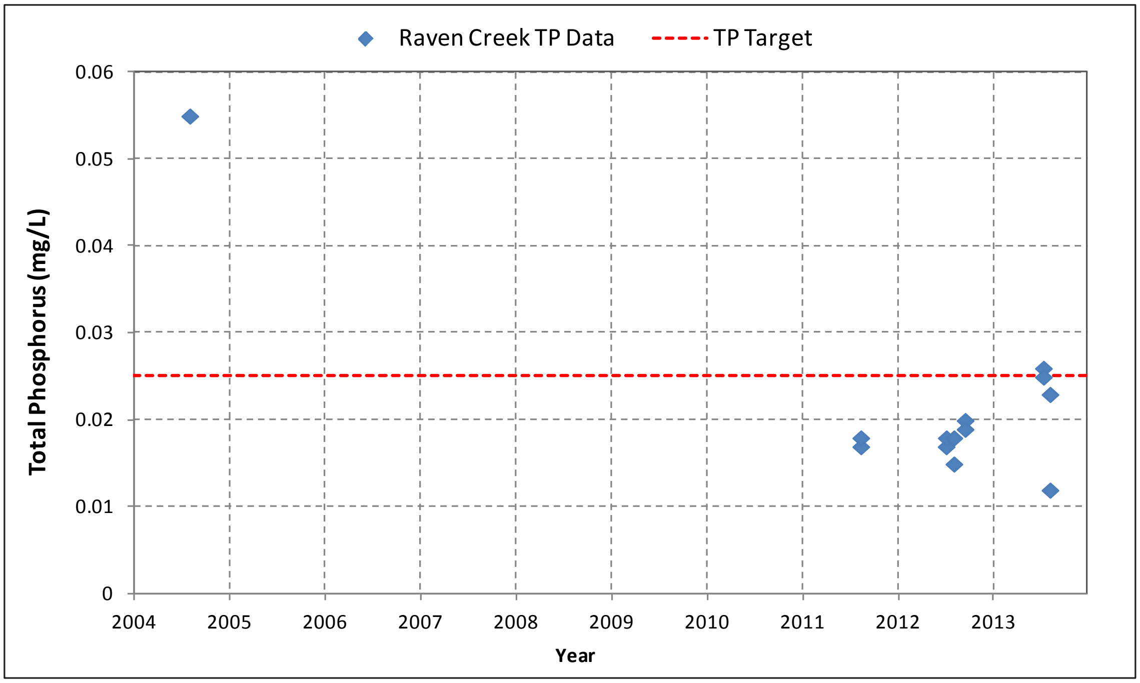

Figure 6-11. Total phosphorus data collected in Raven Creek, 2004-2013

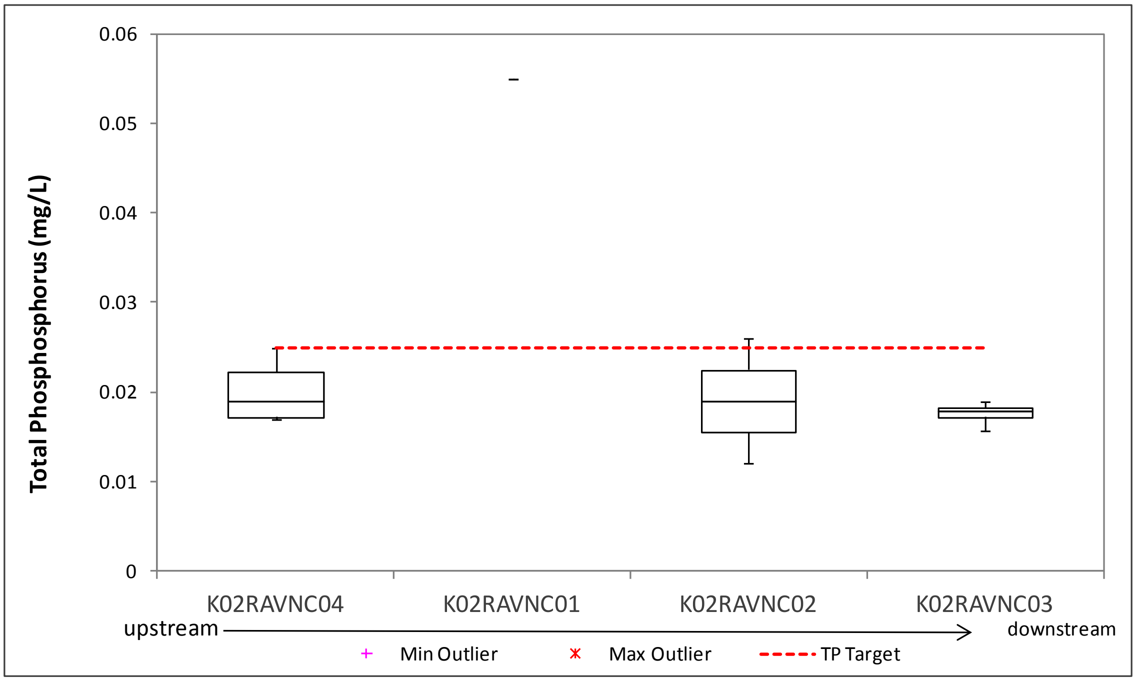

Figure 6-12. Total phosphorus box plots for sites on Raven Creek, 2004-2013, growing season only

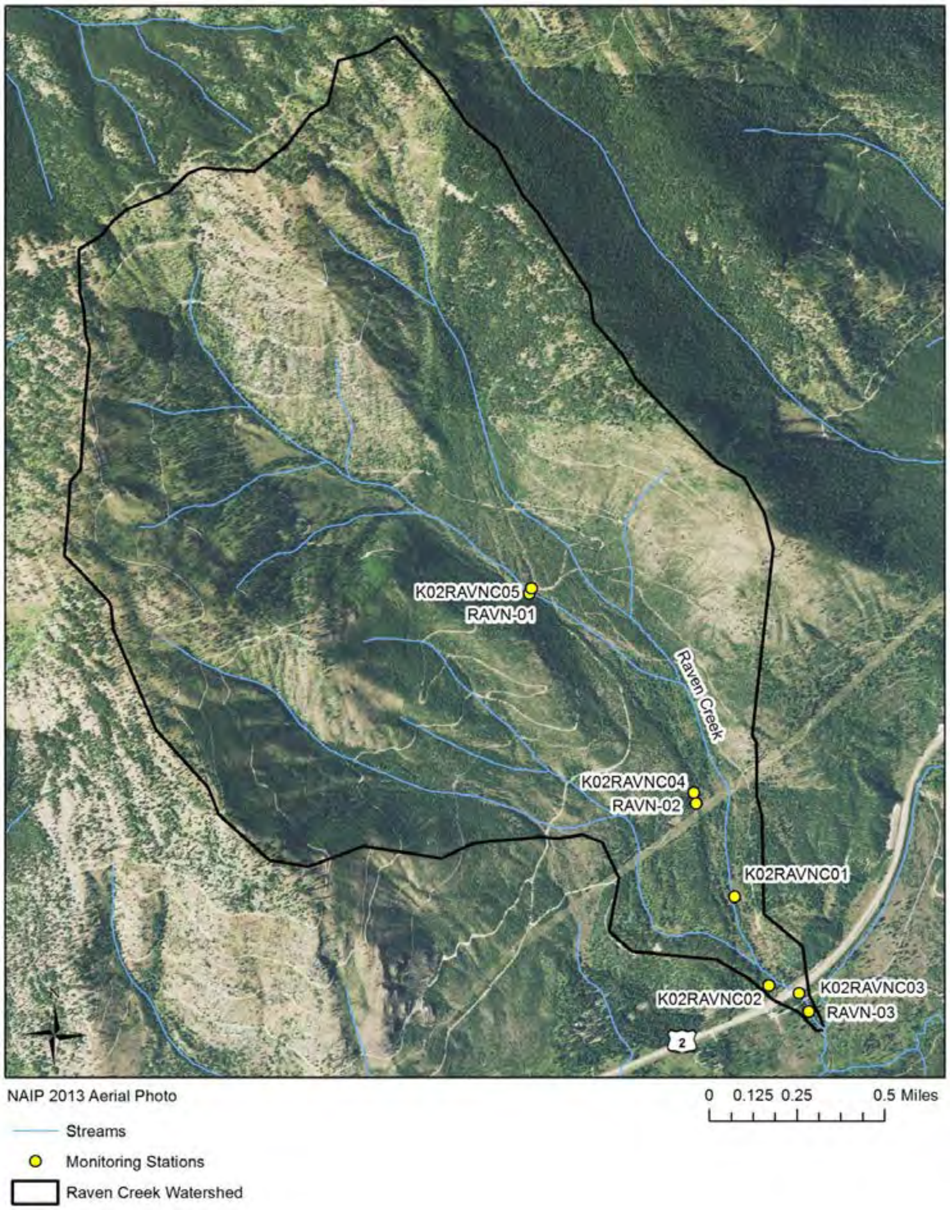

Figure 6-13. Location of the Raven Creek watershed and nutrient monitoring stations

6.5.5.2 Assessment of Loading by Source Categories

At this time, there is uncertainty regarding the sources of phosphorus in the Raven Creek watershed. There are currently no septic systems, point sources, or agriculture in the watershed. As shown in **Figure 5-4**, the watershed is largely forested, and is largely owned by Plum Creek Timber Company. The only known potential human sources of phosphorus are timber harvest and associated land disturbing activities (**see Section 5.5.4**).

Nutrient water quality for Raven Creek is very similar to sediment (see **Section 5.5.4**) in that it is very close to meeting the water quality standard. The elevated sample in 2004 suggests the nutrient impairment may be associated with sediment, although suspended sediment concentrations during growing season sampling were typically very low. The phosphorus could be associated with sediment that enters the stream during higher flows from eroding streambanks, unpaved roads, and/or upland sources (as discussed in **Section 5.6**). Additional monitoring and source assessment work is recommended for Raven Creek but based on the existing sediment impairment and the fact that phosphorus is commonly bound to soil particles, excess phosphorus loading is likely linked to sediment loading. The sediment source assessment concluded that historical harvest practices combined with the Houghton Creek fire (1984) led to excess sediment loading and impairment (**Section 5.5.4**).

6.5.5.3 TP TMDL, Allocations, Current Loading, and Reductions

Based on the measured growing season concentrations, TP load reductions between 0% and 55% are required. In other words, the TP concentration in the creek is sometimes below the target concentration, and no load reduction is required. At its worse, the TP concentration (and associated load) needs to be reduced by 55%. Of the 13 available growing season samples in Raven Creek, only two of them exceed the TP target, which suggests that only minor changes in management activities are needed to meet the TMDL and water quality standard. With the likely connection between the TP and sediment impairment, the conclusion from the sediment source assessment (**Section 5.5.4**) also applies to nutrients – current management practices are facilitating the recovery of Raven Creek but additional time is needed to meet the TMDL.

Table 6-12 shows an example TP TMDL with allocations based on sample data for Raven Creek. The example is presented for the worst case measured conditions in the creek during the growing season (where there is a paired TP and flow measurement). In this case, the example is provided for site K02RAVNC02, which is just upstream of the Highway 2 crossing (**Figure 6-13**).

Table 6-12. Example TP TMDL and allocations for Raven Creek

Allocation	Source Category	Current Load (lbs/day)[1]	% Reduction	Allocation (lbs/day)	Rationale/Assumptions
Load Allocation	Natural Background	0.023	0%	0.023	Assumes a natural background concentration of 0.005 mg/L TP, which is the median TP concentration from the reference dataset for the Northern Rockies ecoregion
	All other nonpoint sources (e.g., roads, timber harvest)	0.095	2%	0.093	The load was calculated by subtracting the natural background load from the measured load.
TMDL	**All Sources**	**0.118**	**2%**	**0.116**	

[1] Based on a measured concentration of 0.026 mg/L and a measured flow of 0.84 cfs on July 18, 2013 at site K02RAVNC02

6.6 SEASONALITY AND MARGIN OF SAFETY

TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety to account for uncertainties between pollutant sources and the quality of the receiving waterbody, and to ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses.

6.6.1 Seasonality

Addressing seasonal variations is an important and required component of TMDL development and throughout this plan seasonality is an integral consideration. Specific examples of how seasonality has been addressed within this document include:

- Water quality targets and subsequent allocations are applicable for the summer-time growing season (July 1st – Sept 30th), to coincide with seasonal algal growth targets.
- Nutrient data used to determine compliance with targets and to establish allowable loads was collected during the summer-time period to coincide with applicable nutrient targets.

6.6.2 Margin of Safety

A margin of safety is a required component of TMDL development. The margin of safety accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999a). This plan addresses MOS implicitly in a variety of ways:

- Static nutrient target values (e.g., 0.100 mg/L NO_3+NO_2 and 0.025 mg/L TP) were used to calculate allowable loads (TMDLs). Allowable exceedances of nutrient targets were not incorporated into the calculation of allowable loads, thereby adding a MOS to established allocations.
- Target values were developed to err on the conservative side of protecting beneficial uses.
- By considering seasonality (discussed above) and variability in nutrient loading.
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development.

6.7 UNCERTAINTY AND ADAPTIVE MANAGEMENT

Uncertainties in the accuracy of field data, nutrient targets, source assessments, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. However, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. The process of adaptive management is predicated on the premise that TMDL targets, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood. Uncertainty is inherent in both the water quality-based and model-based modes of assessing nutrient sources and needed reductions.

For all three streams, there is uncertainty associated with the source assessment and additional monitoring is recommended to refine the source assessment. For Stanley Creek, additional monitoring should be conducted to determine natural background concentrations and to determine potential sources in the Fairway Creek watershed. In Lake Creek, uncertainties exist around groundwater source loading and contributions from tributaries. For Raven Creek, monitoring data indicate borderline nutrient impairment, so there is also uncertainty regarding the degree of impairment; additional monitoring to help with source assessment should also help refine the impairment status.

7.0 TEMPERATURE TMDL COMPONENTS

This portion of the document focuses on temperature as an identified cause of water quality impairment in the Kootenai-Fisher TMDL Project Area. It describes: (1) the mechanisms by which temperature affects beneficial uses of streams; (2) the stream segment of concern; (3) information sources used for temperature TMDL development; (4) temperature target development; (5) assessment of sources contributing to excess thermal loading; (6) the temperature TMDL and allocations; (7) seasonality and margin of safety; and (8) uncertainty and adaptive management.

7.1 TEMPERATURE (THERMAL) EFFECTS ON BENEFICIAL USES

Human influences that reduce stream shade, increase stream channel width, add heated water, or decrease the capacity of the stream to buffer incoming solar radiation all increase stream temperatures. Warmer temperatures can negatively affect aquatic life that depend upon cool water for survival. Coldwater fish species are more stressed in warmer water temperatures, which increases metabolism and reduces the amount of available oxygen in the water. Coldwater fish and other aquatic life may feed less frequently and use more energy to survive in thermal conditions above their tolerance range, which can result in fish kills. Also, elevated temperatures can boost the ability of non-native fish to outcompete native fish if the latter are less able to adapt to warmer water conditions (Bear et al., 2007). Although the TMDL will address increased summer temperatures as the most likely to cause detrimental effects on fish and aquatic life, human influences on stream temperature, such as those that reduce shade, can lead to lower minimum temperatures during the winter (Hewlett and Fortson, 1982). Lower winter temperatures can lead to the formation of anchor and frazzle ice which can harm aquatic life by causing changes in movement patterns (Brown, 1999; Jakober et al., 1998), reducing available habitat, and inducing physiological stress (Brown et al., 1993). Addressing the issues associated with increased summer maximum temperatures will also address these potential winter problems. Assessing thermal effects upon a beneficial use is an important initial consideration when interpreting Montana's water quality standard (**Appendix B**) and subsequently developing temperature TMDLs.

7.2 STREAM SEGMENTS OF CONCERN

One waterbody segment in the Kootenai-Fisher project area appeared on the 2012 Montana impaired waters list as having temperature limiting a beneficial use: Wolf Creek (**Appendix A**, **Figure A-8**).To help put sampling data into perspective and understand how elevated stream temperatures may affect aquatic life, information on fish presence in Wolf Creek and temperature preferences for the most sensitive species are described below.

7.2.1 Fish Presence in Wolf Creek

Because different fish species have varying optimal temperature ranges for survival and some are more sensitive than others to elevated stream temperatures, it is important to identify the fish species within each stream segment of concern. Based on a query of the Montana Fisheries Information System (MFISH), brook trout, Columbia basin redband trout, largescale sucker, longnnose dace, redside shiner, sculpin, and westslope cutthroat/rainbow trout hybrids are all common in Wolf Creek, and mountain whitefish are rare (Montana Department of Fish, Wildlife and Parks, 2013). Although Wolf Creek is a tributary to the Fisher River, which is used rarely by migrating bull trout (Montana Department of Fish, Wildlife and Parks, 2013), Wolf Creek is not currently or potentially suitable for bull trout (Dunnigan, Jim, personal communication 04/02/2012). According to the Montana Fish, Wildlife, and Parks fisheries resource value ratings, Wolf Creek is considered “High-Value” (rating score 2) from river mile 20.8 to 35 (most of the creek upstream of Dry Fork Creek) and the rest of it is “Moderate” (rating score 4) (Montana Department of Fish, Wildlife and Parks, 2013).

Although not a fish, the western pearlshell mussel is a Montana species of concern that inhabits the Wolf Creek watershed (Stagliano and Montana Natural Heritage Program, 2010). Its larvae rely on a fish host for dispersal, and its native host species is westlope cutthroat, but other trout such as those listed above could also serve as a host (Stagliano and Montana Natural Heritage Program, 2010).

7.2.1.1 Temperature Levels of Concern

Special temperature considerations are warranted for the westslope cutthroat trout and Columbia basin redband trout, which are identified in Montana as species of concern. Research by Bear et al. (2007) found that westslope cutthroat maximum growth occurs around 56.5°F, with an optimum growth range (based on 95% confidence intervals) from 50.5–62.6°F. Columbia basin redband trout are a type of rainbow trout, which have a similar optimum growth temperature to westslope cutthroat trout; however, rainbow trout have the ability to grow better over a wider range of temperatures than cutthroat trout, with growth significantly better at temperatures below 44.2° F and above 69.4°F (Bear et al., 2007).

The ultimate upper incipient lethal temperature (UUILT) is the temperature considered to be survivable by 50% of the population over a specified time period. Bear et al. (2007) found the 60-day UUILT for westslope cutthroat trout to be 67.3°F and the 7-day UUILT to be 75.4°F. In contrast they observed that rainbow trout had a 60-day UUILT of 75.7°F and a 7-day UUILT of 78.8°F. Considering a higher level of survival, the lethal temperature dose for westslope cutthroat that will kill 10% of the population in a 24-hour period is 73.0°F (Liknes and Graham, 1988).

The western pearlshell mussel is known to be sensitive to elevated temperatures but less information about optimal growth and lethal temperatures is known about it than its host species (i.e., salmonids); in statewide monitoring of its populations, the mussel has been observed in streams with water temperatures over 77°F (Stagliano, David, personal communication 12/6/2012). This indicates temperature levels of concern for salmonids are lower than for the western pearlshell mussel and that maintaining temperatures that are protective of salmonids will also be protective of the mussel.

7.3 INFORMATION SOURCES AND DATA COLLECTION

As part of this TMDL project, DEQ used several information and data sources to assess temperature conditions in Wolf Creek:

- DEQ assessment file information
- Temperature Related Data Collection
    - 2012 DEQ/EPA stream temperature, flow, riparian shade, and channel geometry data
    - 2012 Plum Creek temperature data

As discussed in **Appendix B** and **Section 7.4.1**, Montana defines temperature impairment as occurring when human sources cause a certain degree of change over the water temperature that occurs as a result of natural sources and human sources that are implementing all reasonable land, soil, and water conservation practices. Because interpreting the standard is more complex than just comparing measured temperatures to the temperature levels of concern discussed above, a QUAL2K water quality model was needed to determine if human sources are causing the allowable temperature change to be exceeded. Model details are presented in **Appendix G** but the model summary and outcome is provided in **Section 7.5**, **Source Assessment**. To assist with model development and assessment of temperature conditions in Wolf Creek, two other categories of data were needed:

- Climate Data
- Montana Department of Natural Resources and Conservation (DNRC) water usage data

7.3.1 DEQ Assessment Files

DEQ maintains assessment files that provide a summary of available water quality and other existing condition information, along with a justification for impairment determinations.

7.3.2 Temperature Related Data Collection

In summer 2012 DEQ and EPA collected temperature data, along with measurements of streamflow, riparian shade, and channel geometry. This information is collectively used within the QUAL2K model to evaluate impairment and the potential for improvement associated with the implementation of all reasonable land, soil, and water conservation practices. The following sections describe the data collected in Wolf Creek for temperature assessment.

7.3.2.1 Temperature Monitoring

In summer 2012 EPA deployed seven temperature loggers in Wolf Creek and five temperature loggers at the mouth of tributaries (**Figure 7-3**). All tributary loggers were deployed in late June but loggers were not deployed in Wolf Creek until mid-July because of high flows in June. All loggers recorded temperatures every 30 minutes until they were retrieved in mid-September. Water temperature data were collected when streamflow tends to be the lowest and air temperatures the highest because that is when aquatic life are exposed to the highest water temperatures of the year. Temperature monitoring sites on Wolf Creek were selected to bracket stream reaches with similar hydrology, riparian vegetation type, valley type, stream aspect, and channel width. Tributary loggers were deployed in the largest tributaries (based on stream order) to help with model development and to identify if those tributaries are having a warming or cooling effect on Wolf Creek. Loggers were deployed following DEQ protocols and a Quality Assurance Project Plan (Montana Department of Environmental Quality, 2005b; Montana Department of Environmental Quality, 2005a; ATKINS, 2012). Temperature data can be obtained by contacting DEQ but are summarized within this document and **Attachment A** of **Appendix G**.

Plum Creek Timber Company, Inc. (Plum Creek), which owns much of the Wolf Creek valley bottom (**Attachment A** of **Appendix G**, **Figure 3**), deployed three temperature loggers in summer 2012, and those data were also used for TMDL development. Like the EPA loggers, the Plum Creek loggers recorded water temperature every 30 minutes. Two temperature loggers were deployed on Wolf Creek and one was deployed midway up the tributary Little Wolf Creek (**Figure 7-1**). The Plum Creek loggers were deployed from late June to early December 2012.

7.3.2.2 Streamflow

Streamflow measurements were collected following DEQ protocols at all temperature monitoring sites (**Figure 7-1**) during logger deployment (June/July), mid-season (August) and logger retrieval (September). There was no streamflow at the uppermost site (WLFC-T0.1) during logger retrieval and there was no streamflow at the mouths of Dry Fork Creek (DRFKC) and Calx Creek (CALXC) during August and September monitoring (**Figure 7-1**).

7.3.2.3 Riparian Shading

Characterization of riparian shade was based on a combination of field data and aerial imagery analysis. EPA and DEQ used a Solar Pathfinder to measure effective shade in September 2012 at seven locations on Wolf Creek near the temperature logger sites (**Figure 7-1**). Effective shade is the percent reduction of incoming solar radiation that reaches the stream because of riparian vegetation and topography. Because of the variability in riparian cover and topography throughout the watershed, a GIS-based model called TTools (v.3.0) (Oregon Department of Environmental Quality, 2001) was used along with field measurements for trees, shrubs, and herbaceous vegetation and a spreadsheet tool (Shadev3.0.xls) (Pelletier, 2012) to estimate the hourly effective shade approximately every 100 feet along the entire stream. The analysis was performed using August 2012 Google Earth aerial imagery to classify vegetation into broad categories (i.e., bare ground/road, herbaceous, shrub, and trees). The 2001 National Land Cover Database identified percent canopy cover for trees, and that information was used to classify trees as sparse, low, medium, or high density. Although the seven Solar Pathfinder measurements were sparse compared to the Shade model output, they indicate the model reasonably approximated effective shade along Wolf Creek; the average error between the field measurements and model output was 3%. Additional details regarding the shade assessment are contained in **Attachment A** of **Appendix G**.

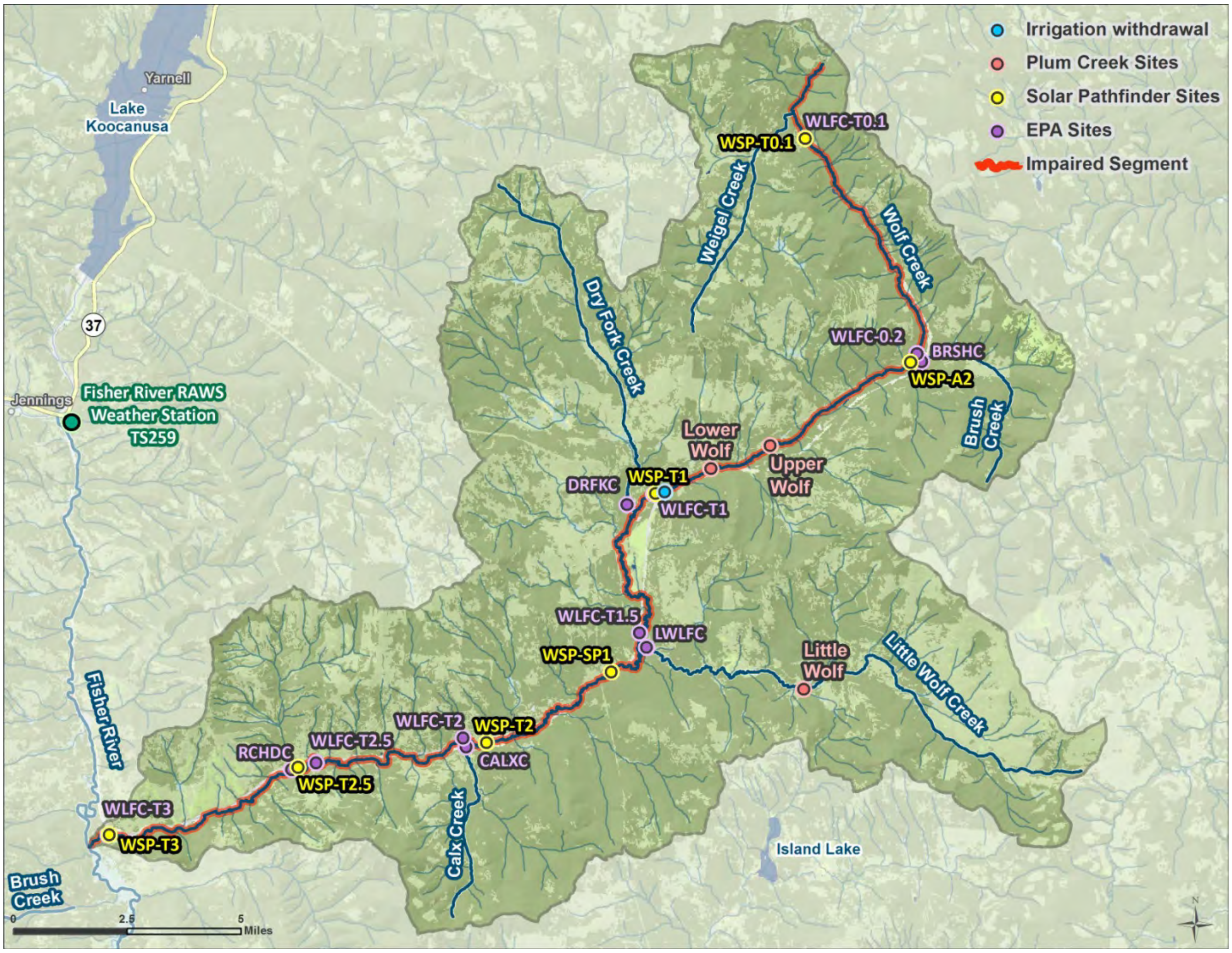

Figure 7-1. Temperature data logger sampling sites on Wolf Creek

7.3.2.4 Channel Geometry

Channel geometry (i.e., width and depth) can influence the rate of thermal loading and is a necessary input for the QUAL2K model. Wide, shallow streams transfer heat energy faster than narrow, deep streams. Human activities that alter peak flows or disturb the riparian vegetation, streambanks, and/or stream channel have the potential to alter channel geometry. Therefore, channel geometry can be used to identify areas that may be destabilized and more prone to rapid thermal loading, particularly in locations where shading is minimal. Channel width (wetted and bankfull) was collected at each of the Wolf Creek shade sites in 2012 (**Figure 7-1**) and [bankfull] width/depth ratios were measured at one site by the KNF in 2011 and at two sites by DEQ and EPA in 2011 (**Figure 5-1**).

7.3.3 Climate Data

Climate data, including air temperature, dew point temperature, wind speed, and cloud cover, are major inputs to the QUAL2K model and are also drivers for stream temperature. Climatic data inputs, including hourly air temperature, were obtained from the nearby Fisher Remote Automatic Weather Station, which is 8 miles from the mouth of Wolf Creek (**Figure 7-1**).

7.3.4 DRNC Water Usage Data

Spatial DNRC water usage data that includes identification of active points of diversion and places of use was obtained from the Natural Resources Information System (Natural Resources Information System, 2012). This information was necessary because streamflow is an important input for the QUAL2K model and irrigation withdrawals have the potential to influence stream temperatures.

7.4 TARGET DEVELOPMENT

The following section describes 1) the framework for interpreting Montana's temperature standard; 2) the selection of target parameters and values used for TMDL development; and 3) a summary of the temperature target values for Wolf Creek.

7.4.1 Framework for Interpreting Montana's Temperature Standard

Montana's water quality standard for temperature is narrative in that it specifies a maximum allowable increase above the naturally occurring temperature to protect fish and aquatic life. Under Montana water quality law, naturally occurring temperatures incorporate natural sources and human sources that are applying all reasonable land, soil, and water conservation practices. Naturally occurring temperatures can be estimated for a given set of conditions using QUAL2K or other modeling approaches, but because water temperature changes daily and seasonally, no single temperature value can be identified to represent standards attainment. Therefore, in addition to evaluating if human sources are causing the allowable temperature change to be exceeded, a suite of temperature TMDL targets were developed to translate the narrative temperature standard into measurable parameters that collectively represent attainment of applicable water quality standards at all times. The goal is to set the target values at levels that occur under naturally occurring conditions but are conservatively selected to incorporate an implicit margin of safety that helps account for uncertainty and natural variability. The target values are protective of the use most sensitive to elevated temperatures, aquatic life; as such, the targets are protective of all designated uses for the applicable waterbody segments.

For Wolf Creek a QUAL2K model was used to estimate the extent of human influence on temperature by evaluating the temperature change between existing conditions and naturally occurring conditions. The model used the data described in **Section 7.3** to simulate existing conditions, and then the model was re-run with riparian shade and water use altered to reflect naturally occurring conditions. If the modeled temperature change between the two scenarios (i.e., existing and naturally occurring) is greater than allowed by the water quality standard (i.e., 0.5-1.0°F, depending on the naturally occurring temperature), this verifies the existing temperature impairment for Wolf Creek. This section discusses whether the model outcome supports the existing impairment listing, but model scenario details are presented in **Section 7.5**, **Source Assessment,** and **Appendix G.**

7.4.2 Temperature Target Parameters and Values

The primary temperature target is the allowable human-caused temperature change (i.e., 0.5-1.0°F, depending on the naturally occurring temperature), and the other targets are those parameters that influence temperature and can be linked to human causes. The other targets are riparian shade, channel geometry, and improved streamflow conditions, where applicable. All targets are described in more detail below.

7.4.2.1 Allowable Human-Caused Temperature Change

The target for allowable human-caused temperature change for Wolf Creek links directly to the numeric portion of Montana's temperature standard for B-1 streams [**ARM 17.30.623(e)**]: When the naturally occurring temperature is less than 66^{o}F, the maximum allowable increase is 1^{o}F. Within the naturally occurring temperature range of 66–66.5^{o}F, the allowable increase cannot exceed 67^{o}F. If the naturally occurring temperature is greater than 66.5^{o}F, the maximum allowable increase is 0.5^{o}F. As stated above, naturally occurring temperatures incorporate natural sources, yet also include human sources that are applying all reasonable land, soil, and water conservation practices.

7.4.2.2 Riparian Shade

Increased shading from riparian vegetation reduces sunlight hitting the stream and, thus, reduces the heat load to the stream. Riparian vegetation also reduces near-stream wind speed and traps air against the water surface, which reduces heat exchange with the atmosphere (Poole and Berman, 2001). In addition, lack of established riparian areas can lead to bank instability, which can result in an overwidened channel.

To help minimize the influence of upland activities on stream temperature, a riparian buffer close to 100 feet is commonly recommended (Ledwith, 1996; Knutson and Naef, 1997; Ellis, 2008). However, several studies have shown that most (85-90%) of the maximum shade potential is obtained within the first 50 feet (Brazier and Brown, 1973; Broderson, 1973; Steinblums et al., 1984) or 75 feet of the channel (CH2M, 2000; Castelle and Johnson, 2000; Christensen, 2000). The Natural Resources Conservation Service (NRCS) Conservation Practice Standard recommends a minimum buffer width of 35 feet, and also includes recommendations to use species with a medium or high shade value and to meet the minimum habitat requirements of aquatic species of concern (Natural Resource Conservation Service, 2011a; 2011b). Based on several literature sources finding that most shade is obtained within a buffer width of 50 feet and that 50 feet is the minimum buffer width for the Montana Streamside Management Zone (Montana Department of Natural Resources and Conservation, 2006), the target is a buffer width of 50 feet. Based on areas of reference riparian health in the upper watershed and documented removal of much of the overstory trees in the valley (see **Section 5.5.5**), as well as the NRCS recommendation for buffers with medium to high shade value, this 50 foot buffer should consist of medium density trees or any vegetation providing equivalent effective shade. The target does not apply to portions where the riparian zone is already at potential or is dominated by vegetation not likely to attain great heights at maturity (e.g., wetland shrub community).

Although the target is 50 feet, the USFS abides by Inland Native Fish Strategy standards in the Wolf Creek watershed for Riparian Habitat Conservation Areas, which sets a buffer ranging from a minimum of 50 feet for seasonally flowing streams to a minimum of 300 feet for fish-bearing streams (U.S. Department of Agriculture, Forest Service, 1995).

DEQ realizes most healthy riparian buffers are comprised of more than a single category of vegetation, but a buffer of medium density trees was used as a shade target throughout Wolf Creek for two reasons: 1) the actual composition of the riparian zone under target shade conditions will vary over time and is too complex to model with QUAL2K, and 2) based on existing vegetation in the watershed and what is known of historical conditions, the effective shade provided by medium density trees was determined to be a reasonable target. Considering the variability in potential vegetation and shade, medium density trees was used as a surrogate to represent the average achievable shade condition; effective shade is the result of topography and vegetative height and density, so the target shade condition could be achieved by a large combination of vegetation types and densities. Additionally, the effective shade potential at any given location may be lower or higher than the target depending on natural factors such as fire history, soil, topography, and aspect but also because of human alterations to the near-stream landscape including roads, the railroad, and riprap that may not feasibly be modified or relocated. The target is provided as a quantitative guide for meeting the standard but since it is intended to represent all reasonable land, soil, and water conservation practices, if those are being implemented, then Wolf Creek will be meeting the riparian shade target.

7.4.2.3 Width/Depth Ratio

A narrower channel with a lower width-to-depth ratio results in a smaller contact area with warm afternoon air and is slower to absorb heat (Poole and Berman, 2001). Also, a narrower channel increases the effectiveness of shading produced by the riparian canopy. A target for width/depth ratio was developed for the sediment TMDLs using reference data (**Section 5.4.1**), and will also apply for temperature: ≤ 21 for sections with a bankfull width less than 30 feet and ≤ 32 for sections with a bankfull width greater than 30 feet. The target is not intended to be specific to every given point on the stream but to maintain current conditions where the target is generally being met. In areas where the target is not being met, actions to improve riparian shade are also anticipated to lower width/depth ratios.

7.4.2.4 Instream Flow (Water Use)

Because larger volumes of water take longer to heat up during the day, the ability of a stream to buffer incoming solar radiation is reduced as instream water volume decreases. In other words, a channel with little water will heat up faster than an identical channel full of water, even if they have identical shading and are exposed to the same daily air temperatures.

Human-caused sedimentation, which is a process than can lower the summer base flow of a stream by reducing groundwater inputs (May and Lee, 2004; Sullivan and Watzin, 2010), is widespread in tributaries to Wolf Creek (USDA Forest Service, 1981; U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 1996; 1998; 1999; Edwards, 2008); however, field observations indicate that small tributaries and particularly those on the south-facing side of the drainage tend to naturally go dry in the summer. Reductions in streamflow because of direct withdrawals of water from Wolf Creek are very limited. DNRC water use data indicates there is only one irrigation withdrawal from Wolf Creek, and it is estimated to withdraw 1.78 cfs daily for flood irrigation (**Attachment A** of **Appendix G, Table A-8**). Given this very limited amount of consumptive water use, there is no water use target.

7.4.3 Target Values Summary

The allowable human-caused temperature change is the primary target that must be achieved to meet the standard. Alternatively, compliance with the temperature standard can be attained by meeting the two temperature-influencing targets (i.e., riparian shade and width/depth ratio). In this approach, if all reasonable land, soil, and water conservation practices are installed or practiced, water quality standards will be met. **Table 7-1** summarizes the temperatures targets for Wolf Creek.

Table 7-1. Temperature Targets for Wolf Creek

Target Parameter	Target Value
Primary Target	
Allowable Human-Caused Temperature Change	If the naturally occurring temperature is less than 66°F, the maximum allowable increase is 1°F. Within the naturally occurring temperature range of 66–66.5°F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F.
Temperature-Influencing Targets: Meeting both will meet the primary target	
Riparian Health - Shade	50 foot buffer with medium density trees, or vegetation providing equivalent effective shade
Width/Depth Ratio	B & C stream types with bankfull width < 30ft: $\leq$ 21 B & C stream types with bankfull width > 30ft: $\leq$ 32

7.4.4 Wolf Creek Existing Conditions and Comparison to Targets

This section includes a comparison of existing data with water quality targets, along with a TMDL development determination for Wolf Creek. QUAL2K model results will be compared to the allowable human-caused temperature change to determine if the target is being exceeded, but most model details will be presented in **Section 7.5**, **Source Assessment**.

Wolf Creek (MT76C001_020) was initially listed for temperature impairment in 1990 because of an instantaneous water temperature of 69°F. The assessment file also documents changes to channel form and shade, both of which could influence water temperatures. Because of the railroad construction in the 1970s, large extents of the stream were channelized and riprapped. During visits at three sites in 1992, dense shrub cover was generally observed, but extensive historic logging that included the removal of overstory in the valley was noted. Overall, human-influenced factors that could increase temperatures in Wolf Creek include the railroad, road network, present and historic agricultural activities (mostly grazing), and timber harvest.

Data Summary and Comparison with Water Quality Targets

To help evaluate the extent and implications of impairment it is useful to evaluate the degree to which existing temperatures may harm fish or other aquatic life. Measured temperatures were warmest for the longest period of time near the mouth (WLFC-T3), where the water temperature on 21 days exceeded 70°F. These temperatures are not in the lethal range discussed in **Section 7.2.1.1**, but maximum daily temperatures throughout Wolf Creek (**Figure 7-2**) were commonly outside of the optimal growth range for both westslope cutthroat trout and Columbia redband trout (i.e., 62.6°F). For tributaries, Dry Fork Creek and Little Wolf Creek were the warmest, with Little Wolf Creek temperatures exceeding 75°F.

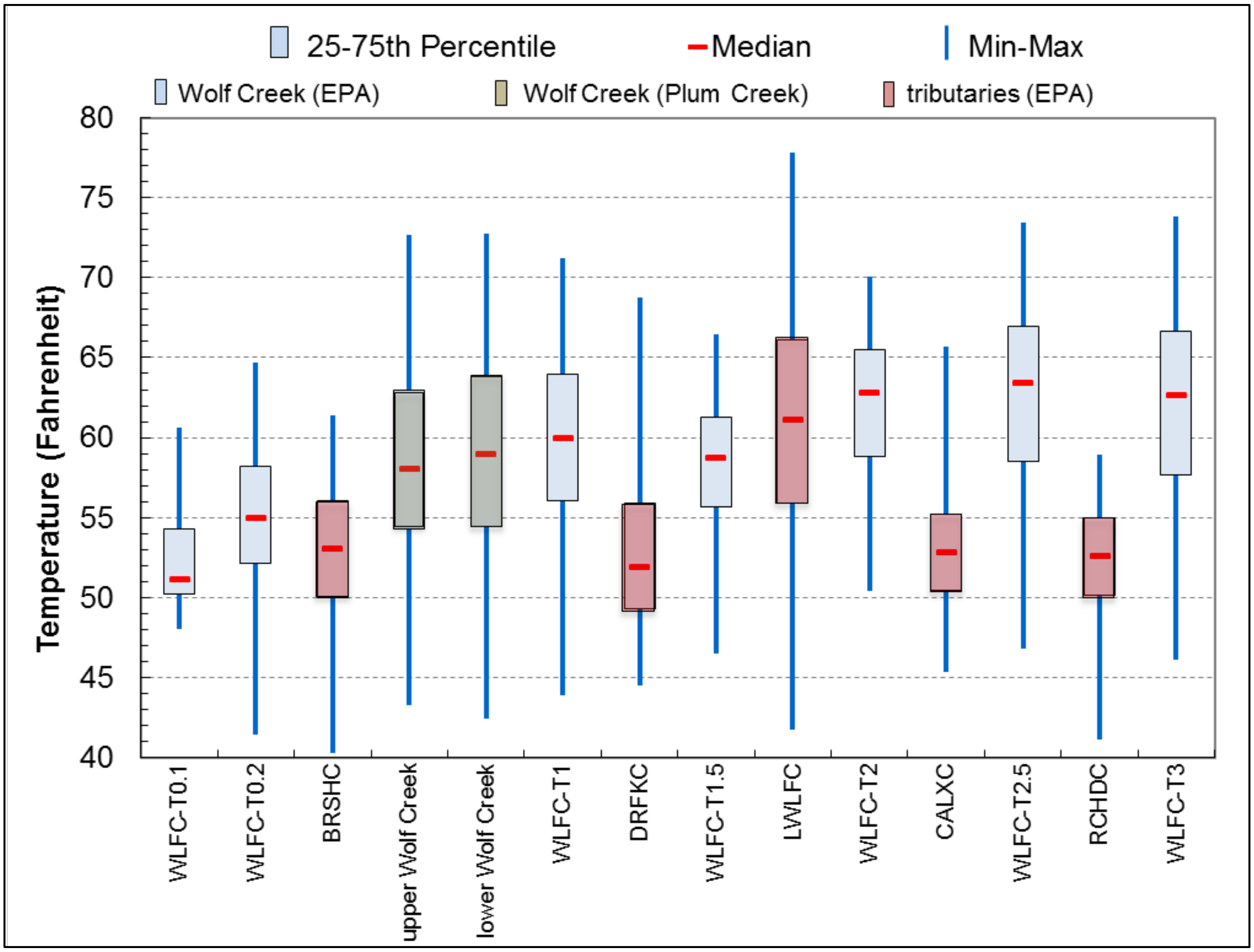

Figure 7-2. 2012 temperature logger monitoring data for Wolf Creek and several tributaries

The QUAL2K model results indicate that the maximum naturally occurring summer temperatures in Wolf Creek are greater than 66.5°F downstream of Dry Fork Creek, meaning human sources cannot cause the temperature to be exceeded by more than 1.0°F upstream of Dry Fork Creek and by more than 0.5°F downstream. Based on the model and temperature data, human sources have caused the allowable change target to be exceeded throughout Wolf Creek, with the increase ranging from 0.6°F to 7.8°F and averaging 4.6°F. There is only a 1 mile section of stream just upstream from site WLFC-T2 where human sources are causing less than a 1.0°F increase.

The existing riparian buffer is predominantly herbaceous ground cover and shrubs, followed by medium and high density trees (**Table 7-2**). Much of the riparian vegetation upstream of Dry Fork Creek (**Figure 7-1**) is a mix of shrubs (primarily alder and dogwood) and conifers. Riparian vegetation in the lower watershed is dominated by the same shrubs as the upper watershed and has interspersed conifers and deciduous trees. Much of the riparian shrubs are dense, but the lack of overstory vegetation reduces the effective shade well below the target. **Figure 7-3** shows the percent difference between the existing effective shade and the target effective shade (based on the Shade Model results). Note, the dark blue section near site WLFC-T1.5 represents a sinuous 6 mile stretch inhabited by beavers. Because there is extensive wetland habitat in that section, the target does not apply and it was excluded from the Shade Model; however, the riparian zone is generally dominated by dense willows and at its potential.

Table 7-2. Composition of the existing riparian buffer 50 feet on both sides of Wolf Creek

Land cover type	Relative area (percent)
Bare ground/road	3.4%
Herbaceous	27.9%
Shrub	34.2%
Sparse trees	2.6%
Low density trees	5.9%
Medium density trees	16.6%
High density trees	9.4%

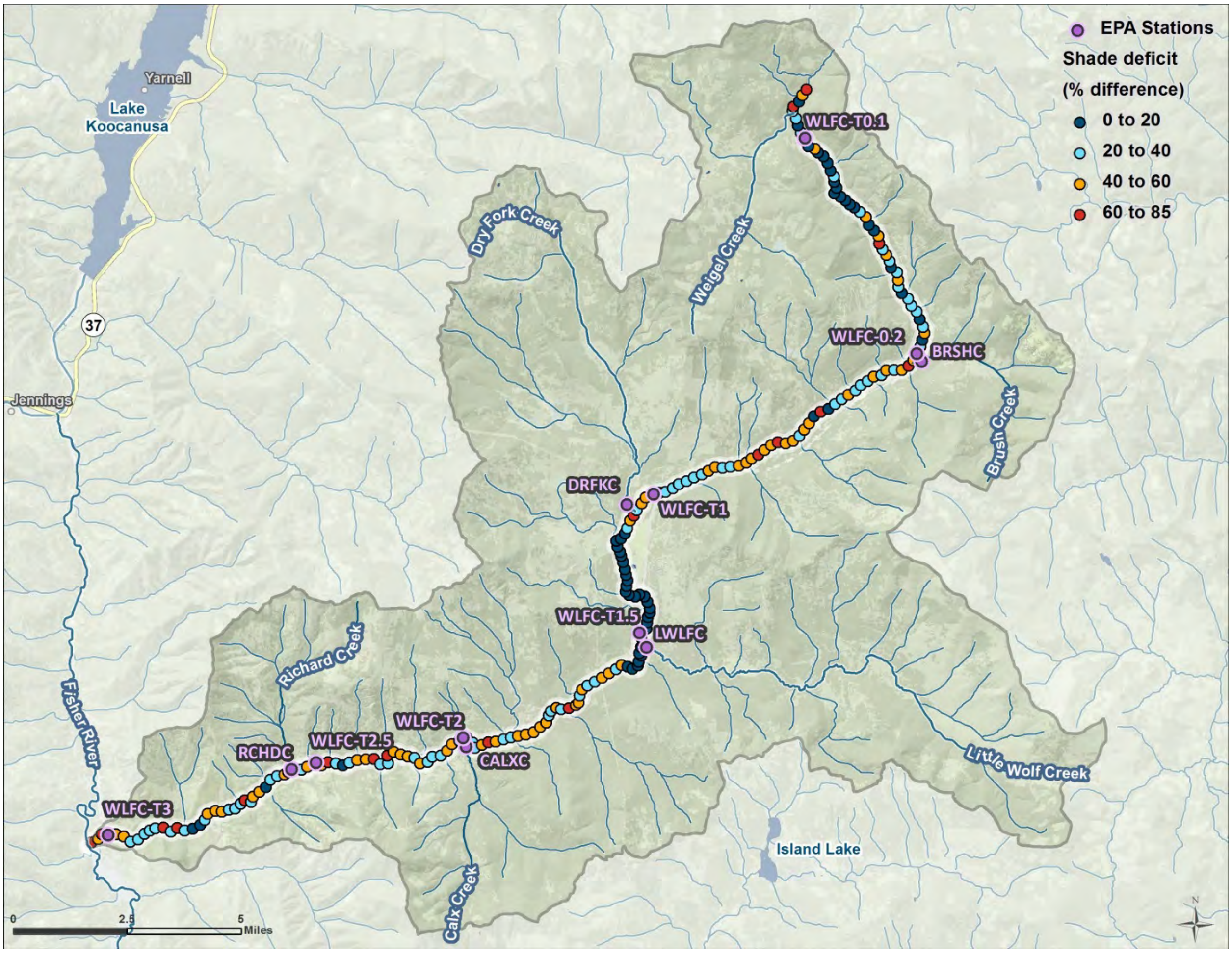

Figure 7-3. The percent of additional effective shade needed to meet the target along Wolf Creek.

The width/depth ratios measured at three sites in 2011 to support sediment TMDL development (**Section 5.5.5**) all met the target value. Channel widths at all shade sites visited in 2012 were similar to those measured in 2011, indicating Wolf Creek is meeting the target for width/depth ratio. Although the channel is not overwidened, which is good for water temperatures, actions such as channel hardening and realignment, which were extensively done in Wolf Creek, can alter a stream's ability to access its floodplain (i.e., entrenchment) and increase stream temperatures by reducing the stream's interaction with groundwater (Poole and Berman, 2001).

Summary and TMDL Development Determination

The human-influenced allowable temperature change target is being exceeded throughout Wolf Creek. Additionally, although width/depth ratios are meeting the target, the riparian vegetation is generally well under the shade target. The dense shrubs present in much of the Wolf Creek riparian zone as well as observations made during the assessment of sediment and habitat data (see **Section 5.5.5**) indicate it is recovering from historical practices but the removal of much of the overstory vegetation in the riparian zone continues to limit shade and contribute to elevated water temperatures that are likely limiting its ability to fully support aquatic life. This information supports the existing impairment listing and a temperature TMDL will be developed for Wolf Creek.

7.5 SOURCE ASSESSMENT

As discussed above, the source assessment for Wolf Creek largely involved QUAL2K temperature modeling. There are no permitted point sources in the watershed. The watershed has been affected by the railroad, road network, present and historic agricultural activities (mostly grazing), and timber harvest. Instead of focusing on the potential contribution of these sources, the source assessment focused on two factors that can be influenced by human activities and are drivers of stream temperature: instream flow and riparian shade.

7.5.1 Wolf Creek Assessment Using QUAL2K

A QUAL2K model was used to determine the extent that human-caused disturbances within the Wolf Creek watershed have increased the water temperature above the naturally occurring level. The evaluation of model results focuses on the maximum daily water temperatures in Wolf Creek during the summer because those are conditions mostly likely to harm aquatic life, the most sensitive beneficial use.

QUAL2K is a one-dimensional river and stream water quality model that assumes the channel is well-mixed vertically and laterally. The QUAL2K model uses steady state hydraulics that simulates non-uniform steady flow. Within the model, water temperatures are estimated based on climate data, riparian shading, and channel conditions. Each stream is segmented into reaches within the model that are assigned the same channel and shade characteristics. Segmentation is largely based on the location of field data, tributaries, irrigation withdrawal/returns, and changes in channel conditions or shading.

Within the model, Wolf Creek was segmented into reach lengths of 0.93 miles. The water temperature and flow data collected from Wolf Creek and five tributaries in 2012, along with channel measurements, irrigation data, and climate data (**Section 7.3**), were used to calibrate and validate the model. Both Dry Fork Creek and Calx Creek were dry at the mouth in August and September, when the model was calibrated and validated, so they had no flow contributing to Wolf Creek within the model. Error rates for the maximum stream temperatures for the calibration and validation were 2.6% and 3.1%, respectively, indicating the model provides a reasonable approximation of maximum daily temperatures in Wolf Creek. While temperatures were monitored at the mouth of the largest tributaries to evaluate if and how they are affecting temperatures in Wolf Creek, due to time and resource constraints measuring effective shade and identifying human influences on tributary water temperatures was outside of the scope of this project.

Flow data at the USGS gage on the nearby Fisher River (#12301990) were evaluated to determine how August streamflow in 2012 (when data were collected) compared to the average August streamflow; flows were at the 77th percentile, indicating they were higher than average.

A baseline scenario and three additional scenarios were modeled to investigate the potential influences of human activities on temperatures in Wolf Creek. The following sections describe those modeling scenarios. Although channel width and depth can influence stream temperatures, the existing channel dimensions were not changed for any of the scenarios because Wolf Creek is meeting the channel width/depth target. A more detailed report of the development and results of the QUAL2K model are included in **Appendix G**.

7.5.1.1 Baseline Scenario (Critical Existing Conditions)

The baseline scenario represents stream temperatures under existing shade and channel conditions in August on a hot, dry year and is the scenario that all others are compared against to evaluate the influence of human sources. The calibrated and validated model was set up entirely on measured conditions and corresponding weather data, but because long-term flow data at the nearby Fisher River gage indicated Wolf Creek summer flows were likely higher than usual (which could result in cooler water temperatures), flow and climate data were adjusted to represent more critical (i.e., hotter and drier) conditions for the baseline scenario. Flow inputs in the model were decreased to represent the 25th percentile flow conditions for August. Climate inputs reflect the median of the warmest four consecutive days in August for the period of record at the Fisher RAWS climate station (2004-2013).

Under the baseline scenario, maximum daily temperatures range from 52.4°F near the headwaters to 74.2°F at the mouth (**Figure 7-4**). Temperatures generally increase in a downstream direction but reset somewhat by decreasing by 2 or more degrees Fahrenheit near river mile 20, which is just upstream of Little Wolf Creek at site WLFCT1.5. The area where temperatures decrease is within the sinuous section of channel with extensive beaver habitat and is also one of the few areas of the creek where it is not adjacent to the railroad (**Figure 5-6**).

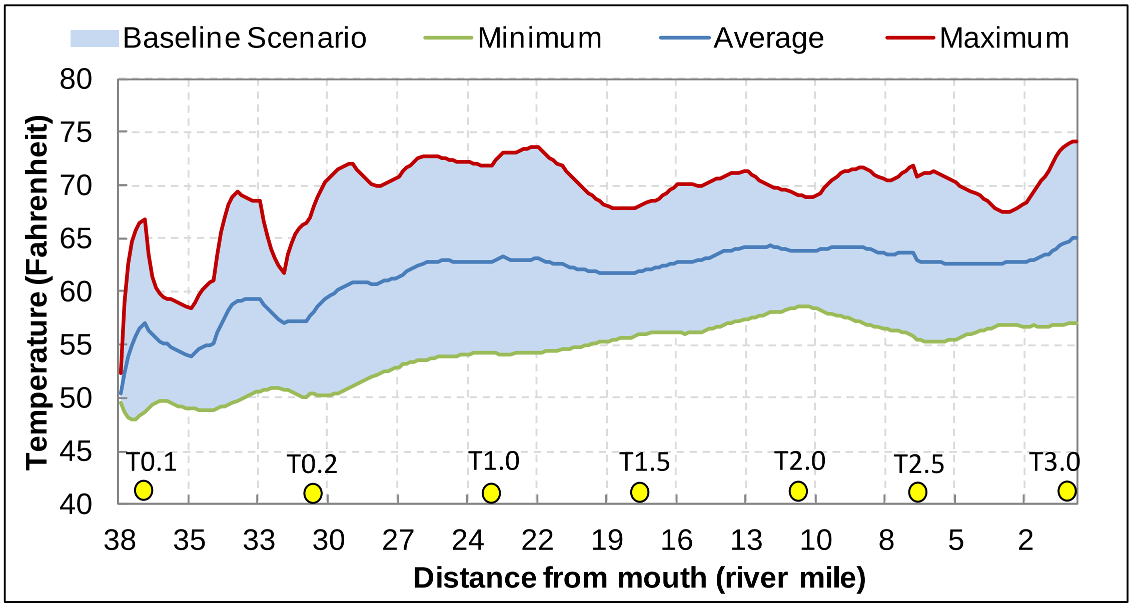

Figure 7-4. Modeled temperatures for the Wolf Creek baseline scenario

7.5.1.2 Water Use Scenario

Although there is no formal target for consumptive water use relative to instream flow because of the limited amount of water withdrawn for irrigation, the naturally occurring condition referenced in the temperature standard includes the use of all reasonable water conservation practices (ARM 17.30.602(17)). Therefore, a water use scenario was conducted to evaluate the effect that water conservation measures resulting in more instream flow would have on temperatures.

In this scenario, the single irrigation withdrawal that is used for flood irrigation (which was estimated at 1.78 cfs daily, see **Appendix G)** is reduced by 15% within the model and that savings of 0.27 cfs (1.78 * 0.15 = 0.27) is allowed to remain in the stream. The Natural Resources Conservation Service Irrigation Guide (Natural Resources Conservation Service, 1997) states that improving an existing irrigation system often increases water application efficiency by more than 30% and installing a new system typically adds an additional 5% to 10% savings. These improvements in efficiency could be used to grow different crops, expand production, or withdraw less water from the stream. Since leaving additional water instream could lower the maximum daily temperature, converting efficiency savings to a lower amount of water usage is the focus of this scenario.

However, per Montana's water quality law, TMDL development cannot be construed to divest, impair, or diminish any water right recognized pursuant to Title 85 (Montana Code Annotated Section 75-5-705, State of Montana, 2011), so any voluntary water savings and subsequent instream flow augmentation must be done in a way that protects water rights. In the water use scenario, a 15% reduction in withdrawal volume was used to simulate the outcome of leaving some of the water saved by implementing improvements to the irrigation network instream. Considering the statistics presented above from the NRCS Irrigation Guide and other sources that evaluated efficiency improvements for different irrigation practices (Negri et al., 1989; Negri et al., 1989; Howell and Stewart, 2003; Osteen et al., 2012) and savings left instream (Kannan et al., 2011), using efficiency gains to reduce withdrawal volume by 15% was selected for the water use scenario. Fifteen percent was chosen to be a reasonable starting point, but as no detailed analysis was conducted of the irrigation network in the Wolf Creek watershed, this scenario is not a formal efficiency improvement goal; it is an example intended to represent the application of water conservation practices for water withdrawals.

The withdrawal occurs at river mile 23.8, which is just upstream of monitoring site WLFC-T1.0 (**Figure 7-1**). Under the water use scenario, improving water use efficiency and withdrawing 15% less water has a minimal effect on temperatures in Wolf Creek. Starting at the withdrawal location and extending to the mouth, maximum daily temperatures averaged 0.06°F less than the baseline scenario, and the largest decrease in maximum daily temperature was 0.21°F. Therefore, consumptive water usage is not causing the allowable temperature change target to be exceeded.

7.5.1.3 Shade Scenario

For the shade scenario, the effective shade inputs to the model were set to represent the target shade condition. Since the target is a 50 foot buffer of medium density trees or any vegetation providing equivalent effective shade, the effective shade generated by a 50 foot buffer of medium density trees along Wolf Creek was calculated using the Shade Model (discussed in **Section 7.3.2.3**) and averaged for each model segment (approximately 1 mile). Based on this scenario, the maximum daily stream temperature is very sensitive to improvements in riparian shade. This scenario resulted in maximum daily temperatures ranging from 52.4°F to 70.2°F, which is decrease from the baseline scenario of 0.63°F to 7.82°F (**Figure 7-5**). Meeting the shade target caused an average decrease in the maximum daily temperature of 4.55°F from the baseline scenario. The maximum decrease was in the upper watershed slightly downstream of Brush Creek and sample site WLFC-T0.2 (river mile 29.9) and the smallest change was in the sinuous section of beaver habitat near site T1.5, where temperatures already decrease in the baseline scenario. The shade scenario indicates that human changes to the riparian vegetation are the primary source of temperature impairment. To illustrate how this scenario relates to current conditions, the average daily effective shade for segments with similar vegetation is presented in **Table 7-3** for the baseline scenario and shade scenario.

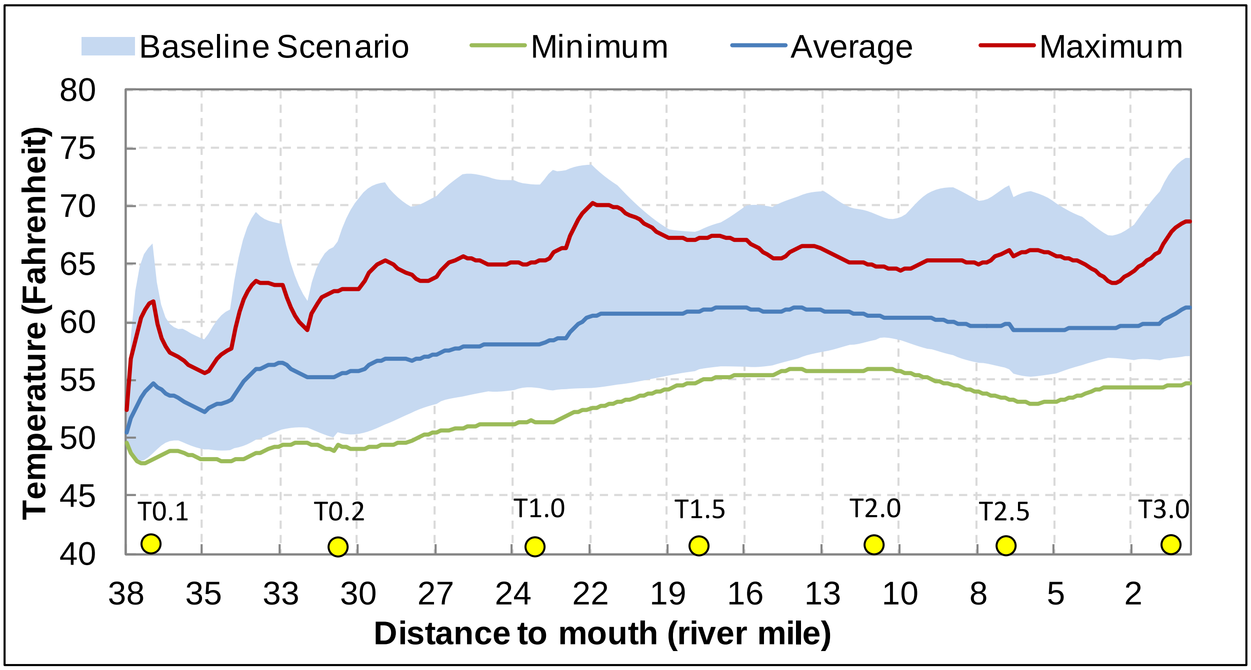

Figure 7-5. Comparison of modeled temperatures between the shade and baseline scenarios

Table 7-3. Comparison of effective shade between the existing condition and shade scenario

Segment (river mile)	Current Conditions, Baseline Scenario	Shade Scenario
37.8 - 30.6	72%	82%
30.6 - 26.6	55%	72%
26.6 - 25.0	48%	69%
25.0 - 22.9	50%	67%
22.9 - 17.7[1]	47%	47%
17.7 - 11.0	50%	63%
11.0 - 6.5	52%	65%
6.5 - 0	52%	63%

[1] Section containing wetland shrubs that were not adjusted for the shade scenario

7.5.1.4 Naturally Occurring Scenario (Full Application of BMPs with Current Land Use)

The naturally occurring scenario represents Wolf Creek water temperatures when all reasonable land, soil, and water conservation practices are implemented (**ARM 17.30.602**). Since the current width/depth ratios are meeting the target and reflected in the baseline scenario, the naturally occurring scenario is a combination of the shade and water use scenarios. Although water conservation measures resulting in additional instream flow will only cause a slight decrease in maximum daily stream temperatures (**Section 7.5.1.2**), the conditions applied in the water use scenario were included because water conservation is a component of the naturally occurring condition. Water users in the Wolf Creek watershed are encouraged to work with the USDA Natural Resource Conservation Service, the Montana Department of Natural Resources and Conservation, the local conservation district, and other local land management agencies to review their irrigation systems, practices, and the variables that may affect overall irrigation efficiency (Negri and Brooks, 1990; Natural Resources Conservation Service, 1997). If warranted and practical, users may consider changes that increase instream flows, and/or reduce warm water return flows in Wolf Creek.

Given the small influence of water withdrawals, the target for maximum allowable human-influenced temperature change could be achieved entirely by increasing the effective shade. However, water conservation measures resulting in more instream flow would slightly decrease temperatures, meaning slightly less improvement in effective shade would be necessary to meet the water quality standard. The naturally occurring scenario maximum daily temperatures ranged from 52.36°F to 69.96°F, with an average of 64.59°F. Based on these results, the naturally occurring temperature is less than 66.0°F until approximately 0.15 miles downstream of Dry Fork Creek (river mile 22.76), and an increase of 1°F is allowed from human sources, but downstream of that location, human sources are not allowed to increase stream temperatures by more than 0.5°F (**Figure 7-6**).

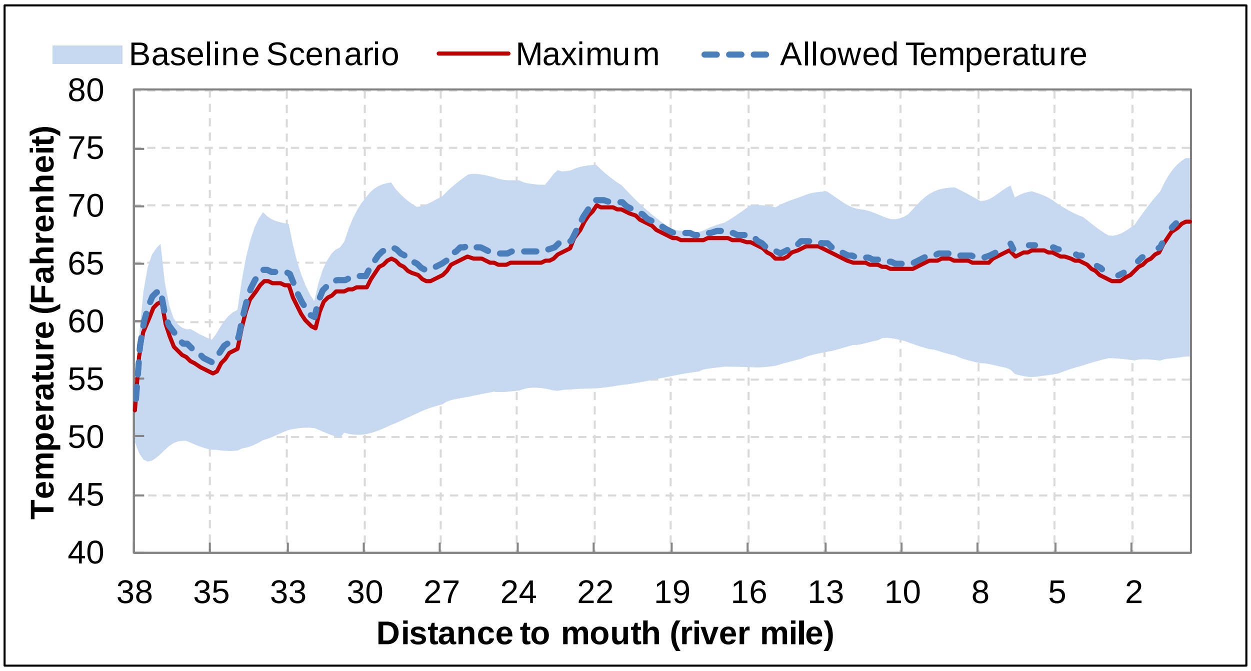

Figure 7-6. The maximum naturally occurring temperature relative to the existing condition (baseline scenario) and the allowed temperature

The naturally occurring scenario results indicate there is the potential for significant reductions in stream temperatures relative to the existing condition (baseline scenario): the potential temperature decreases from this scenario as compared to the baseline scenario ranged from 0.72°F to 7.82^{o}F, with an average decrease of 4.60°F (**Figure 7-7**). Like the shade scenario, the maximum decrease was in the upper watershed slightly downstream of sample site WLFC-T0.2 and the smallest change was near site T1.5 (**Figure 7-8**).

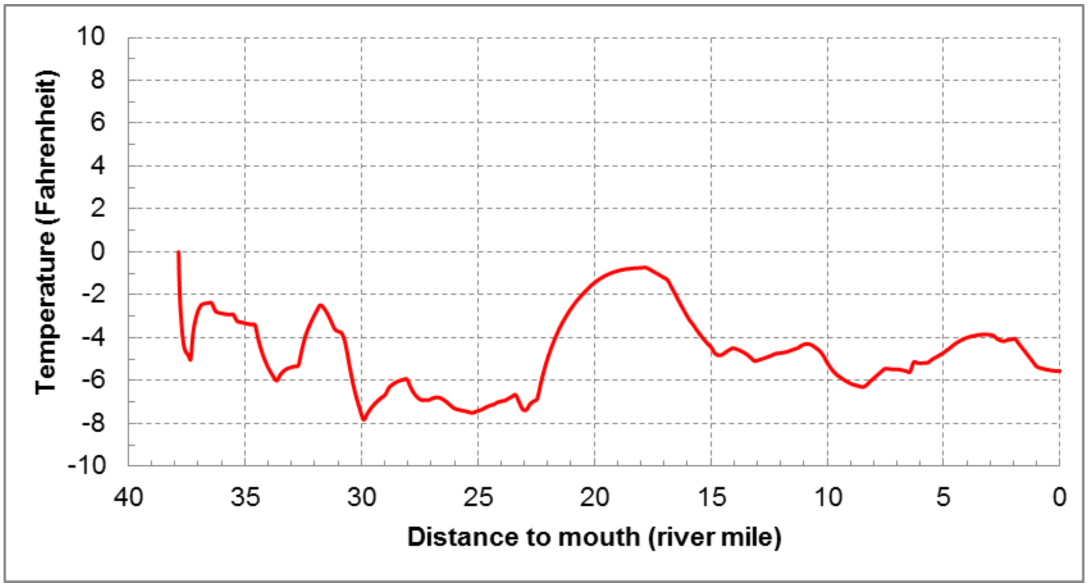

Figure 7-7. Temperature difference between the baseline and naturally occurring scenario

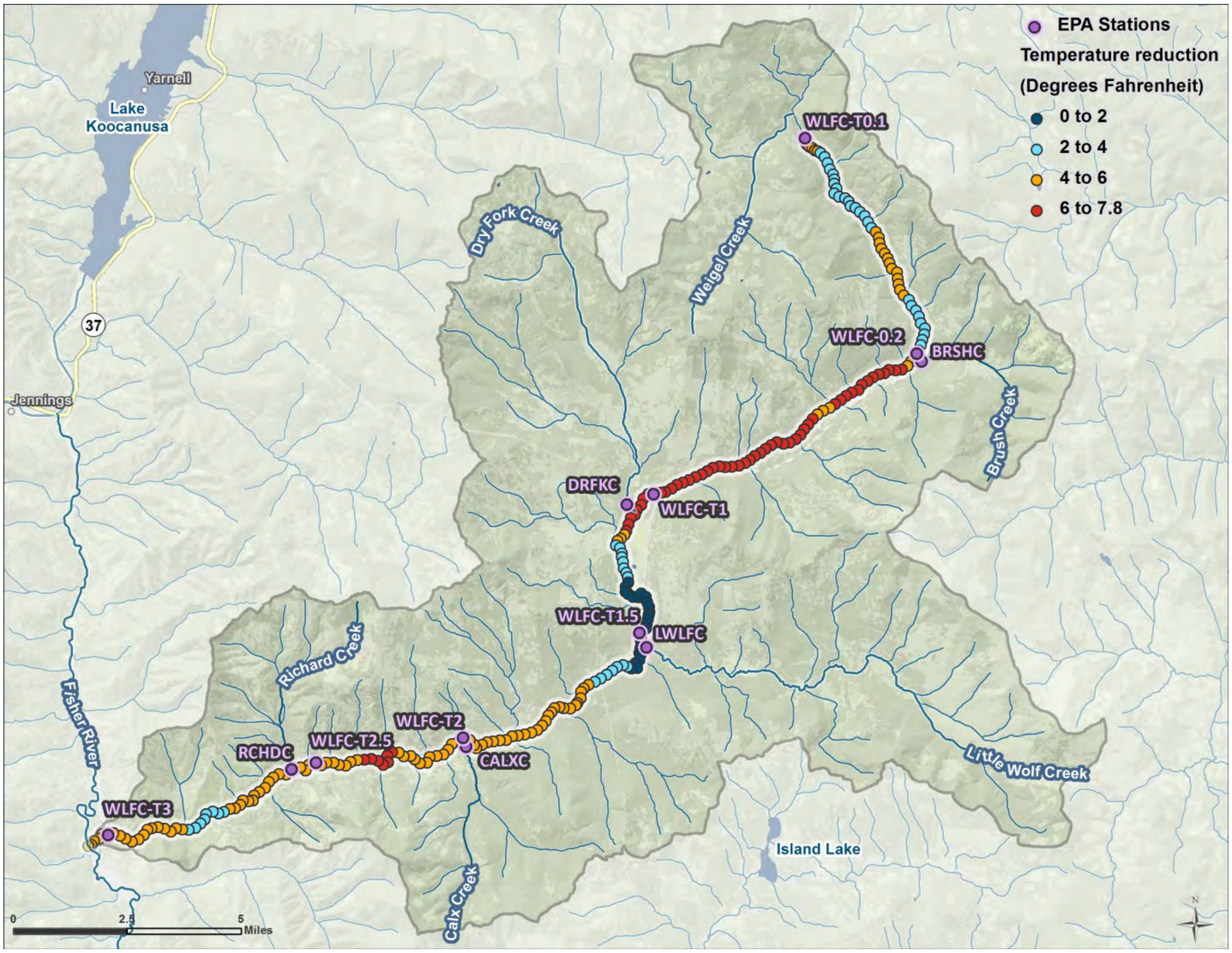

Figure 7-8. Temperature reductions that can be obtained under naturally occurring conditions (relative to the baseline scenario)

7.5.2 QUAL2K Model Assumptions

The following is a summary of the significant assumptions used during the QUAL2K model development:

- Wolf Creek can be divided into distinct segments, each considered homogeneous for shade, flow, and channel geometry characteristics. Monitoring site locations were selected to be representative of segments of Wolf Creek.
- Stream meander and subsurface flow paths (both of which may affect depth-velocity and temperature) are inherently represented during the estimation of various parameters (e.g., stream slope, channel geometry, and Manning's roughness coefficient) for each segment.
- Weather conditions at the Fisher River RAWS, which were elevation-corrected, are representative of local weather conditions along Wolf Creek. Adjustments made to streamflow and climate for the baseline scenario adequately represent existing conditions on a hot, dry summer.
- Shade Model results are representative of riparian shading along segments of Wolf Creek.
- All of the cropland associated with water rights is fully irrigated. No field measurements of irrigation withdrawals or returns were available. Application of some water conservation measures resulting in a 15% decrease in water withdrawn is reasonable and consistent with the definition of the naturally occurring condition.
- The effective shade provided by a 50 foot buffer of medium density trees is achievable and consistent with the definition of the naturally occurring condition.

7.6 TEMPERATURE TMDLS AND ALLOCATIONS

Total maximum daily loads (TMDLs) are a measure of the maximum load of a pollutant a particular waterbody can receive and still maintain water quality standards (**Section 4.0**). A TMDL is the sum of wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources. A TMDL includes a margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. Allocations represent the distribution of allowable load applied to those factors that influence loading to the stream. In the case of temperature, thermal loading is assessed.

7.6.1. Temperature TMDL and Allocation Framework

Because stream temperatures change throughout the course of a day, the temperature TMDL is expressed as the instantaneous thermal load associated with the stream temperature when in compliance with Montana's water quality standards. As stated earlier, the temperature standard for Wolf Creek is defined as follows: The maximum allowable increase over the naturally occurring temperature is 1^{o}F, when the naturally occurring temperature is less than 66^{o}F. Within the naturally occurring temperature range of $66–66.5^{o}$F, the allowable increase cannot exceed 67^{o}F. If the naturally occurring temperature is greater than 66.5^{o}F, the maximum allowable increase is 0.5^{o}F. Montana's temperature standard that applies to Wolf Creek relative to naturally occurring temperatures is depicted in **Figure 7-9**. As stated in **Section 7.4.4**, maximum daily temperatures in Wolf Creek during the baseline scenario are typically greater than 66.5^{o}F for the lower half of the watershed (downstream of Dry Fork Creek), which means the allowable increase caused by human sources during the hottest part of the summer is typically 0.5°F in the lower watershed and 1.0°F in the upper watershed.

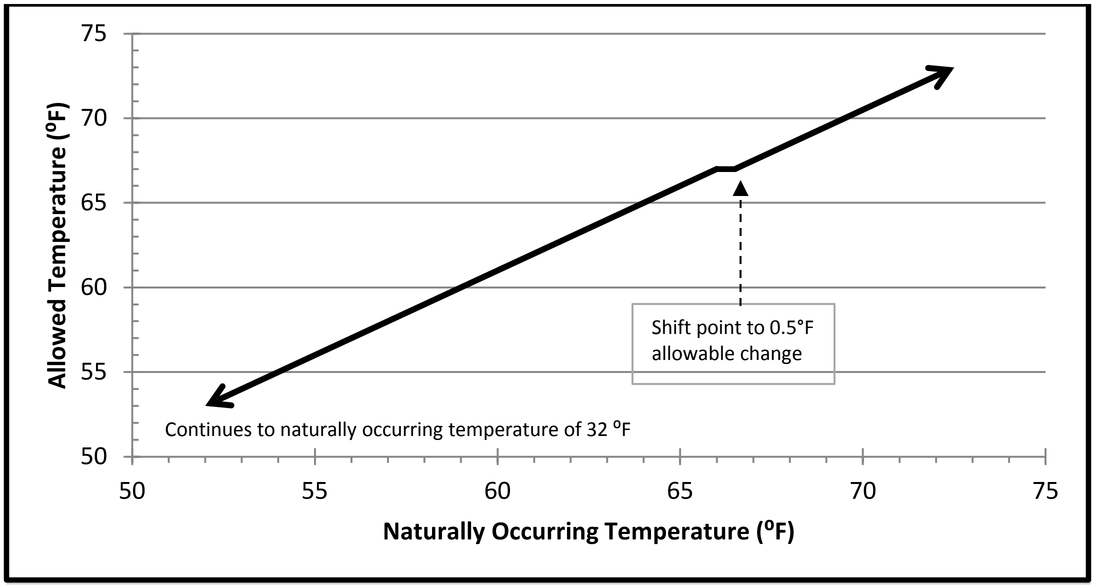

Figure 7-9. Line graph of the temperature standard that applies to Wolf Creek

For any naturally occurring temperature over 32°F (i.e., water's freezing point), the allowable instantaneous thermal total maximum load (kcal/per second) can be calculated using the standard to identify the allowable human-caused increase (stated above and shown in **Figure 7-9**) and **Equation 7-1.**

Equation 7-1: $\text{TMDL} = (((T_{NO} + \Delta) - 32) * 5/9) * Q * 28.3$

Where:

TMDL = allowable thermal load (kcal/s) above 32°F
T_{NO} = naturally occurring water temperature (°F)
Δ = allowable increase above naturally occurring temperature (°F)
Q = streamflow (cfs)
28.3 = conversion factor

The instantaneous load is most appropriate expression for a temperature TMDL because water temperatures fluctuate throughout the day and an instantaneous load allows for evaluation of human caused thermal loading during the daytime when fish are most distressed by elevated water temperatures and when human-caused thermal loading would have the most effect. Although EPA encourages TMDLs to be expressed in the most applicable timescale, it also requires TMDLs to be presented as daily loads (Grumbles, Benjamin, personal communication 2006). Any instantaneous TMDL calculated using **Equation 7-1**, which provides a load per second, can be converted to a daily load (kcal/day) by multiplying by 86,400 (which is the number of seconds in a day).

Because calculation of the TMDL on any timescale relies on the identification of the naturally occurring condition, which fluctuates over time and within a stream, it generally requires a water quality model. However, the shade and width/depth targets that will be met when all reasonable land, soil, and water conservation practices are applied and the water conservation efforts that fall under the definition of naturally occurring are also measurable components of meeting the TMDL and water quality standard. Meeting targets for effective shade and width/depth ratio, and applying all reasonable water conservation measures collectively provide an alternative method for meeting and evaluating the TMDL that more directly translates to implementation than an instantaneous or daily thermal load.

Therefore, these temperature-influencing measures are being provided as a surrogate TMDL. An example instantaneous TMDL will also be provided. Conceptually, the allocations for the surrogate TMDL and numeric TMDL are the same: the entire load is allocated to natural sources and nonpoint human sources that influence temperature (by altering effective shade, width/depth ratio, and instream flow). Human sources should follow all reasonable land, soil, and water conservation practices.

7.6.2 Temperature TMDL and Allocations for Wolf Creek

The example TMDL expressed as an instantaneous load is presented in **Table 7-4** and the surrogate TMDL and allocations are presented in **Table 7-5**. The example TMDL is a direct translation of the water quality standard into a thermal load. There are no point sources and the entire allowable load is allocated to natural and human sources that influence temperature. The example TMDL is based on the modeled naturally occurring maximum daily temperature at the mouth during a hot summer with low flow (9.4 cfs). The naturally occurring temperature used in the example is 68.60°F, which means there is an allowable increase of 0.5°F and the allowable temperature would be 69.1°F. The maximum daily temperature at the mouth under the baseline scenario representing critical existing conditions was 74.15°F (which is only 0.25°F above the measured maximum daily temperature in 2012). The calculation for the example TMDL following E**quation 7-1** is shown below:

$$\text{TMDL} = ((68.6 + 0.5) - 32) * 5/9) * 9.4 * 28.3 = 5{,}483 \text{ kcal/second}$$

The surrogate TMDL contains allocations to temperature-influencing factors that will result in standards attainment when met. Because there are no point sources, there is no wasteload allocation. There is an implicit margin of safety (MOS); the main factor in the MOS is that although there is an allowable increase over the naturally occurring condition, when implementing the TMDL, human sources should follow all reasonable land, soil, and water conservation practices. Additional details about the MOS are described in **Section 7.7**.

Table 7-4. Example Instantaneous Temperature TMDL and Allocation for Wolf Creek

Source Type	Modeled Existing Load (kcal/sec)	TMDL/Load Allocation (kcal/sec)	Percent Reduction Needed
Natural and human sources that influence temperature	6,229	5,483	12%

Table 7-5. Surrogate Temperature TMDL and Allocations for Wolf Creek

Source Type	Surrogate Allocation
Land uses and practices that reduce riparian health and shade provided by near-stream vegetation along Wolf Creek.	• Improve to and maintain a 50 foot buffer with medium density trees or any vegetation providing equivalent effective shade
Land uses and practices that result in the overwidening of the stream channel such that widths are increased, depths are decreased, and thermal loading is accelerated	No increase in average width or width/depth ratios due to human-caused sources • Where bankfull width < 30ft, a width/depth ratio ≤ 21 • Where bankfull width > 30ft: a width/depth ratio ≤ 32
Inefficient consumptive water use	• Application of all reasonable water conservation practices
Surrogate TMDL	**Application of all reasonable land, soil, and water conservation practices for human sources that could influence stream temperatures. This primarily includes those affecting riparian shade, channel width, and instream flow.**

7.6.2.1 Meeting Temperature Allocations

Since riparian shade is the primary source of the impairment, improving the effective shade will be the primary mechanism for implementing and achieving the TMDL. DEQ realizes that re-establishment of a riparian overstory and meeting the effective shade target will likely take a long time. In most instances, current management practices are meeting the intent of the allocations, and the commitment to improving water quality needs to be maintained so that the existing riparian vegetation can continue to mature. The targets and allocations represent the desired conditions that would be expected in most areas along the stream, but as discussed relative to shade, width/depth ratios, and water conservation in the target and source assessment sections (**Sections 7.4.2** and **7.5**), DEQ acknowledges that the allocations may not be achievable at all locations along the stream. The surrogate TMDL provides a measure of conditions that equate to meeting the temperature standard, but the intent and measure of success for all allocations is to follow all reasonable land, soil, and water conservation practices. Future evaluations of TMDL implementation and impairment status will not only assess conservation practices in the watershed but will also use adaptive management (as described in **Section 7.8** and **11.2**) to determine if targets applied within this document are still appropriate.

7.7 SEASONALITY AND MARGIN OF SAFETY

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety (MOS) were applied during development of the Wolf Creek temperature TMDL.

Seasonality addresses the need to ensure year-round beneficial-use support. Seasonality is addressed for temperature in this TMDL document as follows:

- Temperature monitoring and modeling occurred during the summer, which is the warmest time of the year and when instream temperatures are most stressful to aquatic life.
- Effective shade for Wolf Creek was based on the August solar path, which is typically the hottest month of the year.
- Although the maximum daily temperature was focused on for the source assessment and impairment characterization because it is mostly likely to stress aquatic life, sources affecting maximum stream temperatures can also alter daily minimum temperatures year-round.
- Addressing the sources causing elevated summer stream temperatures will also address sources that could lower the minimum temperature at other times of the year.
- Temperature targets, the TMDL, and load allocations apply year round, but it is likely that exceedances occur mostly during summer conditions.

The MOS is included to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. The MOS is addressed in several ways for temperature as part of this document:

- Although there is an allowable increase from human sources beyond those applying all reasonable land, soil, and water conservation practices, the surrogate allocations are expressed so human sources must apply all reasonable land, soil, and water conservation practices.
- Montana's water quality standards are applicable to any timeframe and any season. The temperature modeling analysis for Wolf Creek investigated stream temperatures during summer when effects of increased water temperatures are most likely to have a detrimental effect on aquatic life. Additionally, flow and climatic conditions were slightly adjusted from the

sampling year to represent stream temperatures under more critical conditions than those observed in 2012.

- Despite the limited amount of irrigation in the watershed and modest improvement in stream temperature that could be obtained by implementing conservation measures to leave additional water instream, the source assessment and allocations address consumptive use as a potential human source and recommend the use of all reasonable water conservation measures.
- Compliance with targets and refinement of load allocations are all based on an adaptive management approach (**Section 7.8**) that relies on future monitoring and assessment for updating planning and implementation efforts.

7.8 UNCERTAINTY AND ADAPTIVE MANAGEMENT

Uncertainties in the accuracy of field data, source assessments, water quality models, loading calculations and other considerations are inherent when evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management approaches is a key component of ongoing TMDL implementation activities. Uncertainties, assumptions and considerations are applied throughout this document and point to the need for refining analyses when needed.

The process of adaptive management is predicated on the premise that TMDLs, allocations and their supporting analyses are not static, but are processes which are subject to periodic modification and adjustment as new information and relationships are better understood. As further monitoring and assessment is conducted, uncertainties with present assumptions and consideration may be mitigated via periodic revision or review of the assessment which occurred for this document. As part of the adaptive management approach, changes in land and water management that affect temperature should be tracked. As implementation of restoration projects which reduce thermal input or new sources that increase thermal loading arise, tracking should occur. Known changes in management should be the basis for building future monitoring plans to determine if the thermal conditions meet state standards.

Uncertainty was minimized during data collection because EPA temperature and field data were collected following a Quality Assurance Project Plan (QAPP) (ATKINS, 2012) and adhering to DEQ sampling protocols (Montana Department of Environmental Quality, 2005b; Montana Department of Environmental Quality, 2005a). A QAPP was also completed for the QUAL2K model (Tetra Tech, Inc., 2012), but there was more uncertainty associated with the model than with the field data because numerous assumptions had to be made to help simulate existing and naturally occurring conditions. Modeling assumptions are briefly described in **Section 7.5.2** but are further detailed within the model report in **Appendix G**.

The largest source of uncertainty is regarding the targets and conditions used to represent the naturally occurring condition. The target for width/depth ratio was developed as part of the sediment TMDL process (**Section 5**) and is based on reference data. The target for effective shade from riparian vegetation is intended to represent the reference condition (i.e., highest achievable) and is based on field observations, communication with stakeholders, and best professional judgment. It was selected to be conservative yet achievable, and as discussed in the target and source assessment sections (**Sections 7.4** and **7.5**), the ultimate goal and measure of success is implementation of all reasonable land, soil, and water conservation practices. Since no information is known regarding current irrigation practices within the watershed, there is also uncertainty regarding current conservation practices and the potential for improvement. This uncertainty is the reason there is no set target for improving instream flow or numeric allocation. Literature values were used to estimate the potential for additional instream flow if additional water conservation measures are necessary and implemented. Other areas of uncertainty related to the model are associated with assumptions regarding channel dimensions and groundwater temperatures; limited information for those sources was used and applied throughout the watershed. Riparian shade is highly variable in the watershed but a comparison between the field measured effective shade values and values simulated via the Shade Model indicate the model reasonably approximated existing shade conditions within the watershed. Although this uncertainty within the model results in error bars around the modeled temperatures for each scenario, the magnitude of temperature increase caused by human sources still exceeds the allowable change for most of Wolf Creek. Additional details regarding uncertainty associated with the model are contained in **Appendix G**.

The TMDLs and allocations established in this section are meant to apply to recent conditions of natural background and natural disturbance. Under some periodic natural conditions, such as fire, it may not be possible to satisfy all targets, loads, and allocations because of natural short-term affects to temperature. Additionally, fire has the potential to alter the long-term vegetative potential. The goal is to ensure that management activities are undertaken to achieve loading approximate to the TMDL within a reasonable time frame and to prevent significant long-term excess loading during recovery from significant natural events.

Any factors that increase water temperatures, including global climate change, could impact thermally sensitive fish species in Montana. The assessments and technical analysis for the temperature TMDL considered a worst case scenario reflective of current weather conditions, which inherently accounts for any global climate change to date. Allocations to future changes in global climate are outside the scope of this project but could be considered during the adaptive management process if necessary.

8.0 METALS TMDL COMPONENTS

This portion of the document addresses metals water quality impairments in the Kootenai-Fisher TMDL project area. It includes:

- Metals designated use impacts
- Stream segments of concern
- Water quality data and information sources
- Water quality targets and comparison to existing conditions for each impaired stream
- Metals source assessments
- Metals total maximum daily loads and allocations
- Seasonality and margin of safety
- Uncertainty and adaptive management

8.1 EFFECTS OF METALS ON DESIGNATED BENEFICIAL USES

Metals concentrations exceeding the aquatic life and/or human health standards can impair support of numerous designated beneficial uses including: aquatic life, drinking water, and agriculture. Within aquatic ecosystems, metals can have a toxic, carcinogenic, or bioconcentrating effect on biota. Likewise, humans and wildlife can suffer acute and chronic effects from consuming water or fish with elevated metals concentrations. High metals concentrations can be toxic to plants and animals and therefore can affect irrigation. Although arsenic and antimony are metalloids, they are treated as metals for TMDL development due to the similarity in sources, environmental effects and restoration strategies.

8.2 STREAM SEGMENTS OF CONCERN

Six waterbody segments in the Kootenai-Fisher TMDL Project Area are listed as impaired due to metals in the most recent (2012) 303(d) List and associated 2012 Water Quality Integrated Report. These waterbodies include Stanley Creek, Snowshoe Creek, Fisher River, Lake Creek, Big Cherry Creek and Libby Creek. Additional information regarding the specific metals impairments identified on the 2012 303(d) List is contained within **Table 1-1.**

The DEQ performed updated assessments on all six of these waterbodies using the data sources defined below in **Section 8.3**. The updated assessments confirmed metals impairment conditions for Stanley Creek, Snowshoe Creek, Lake Creek and Big Cherry Creek (**Figure 8-1**). The metals assessment results for these four streams are included within **Section 8.4.3**. No metals impairment conditions were identified for Libby Creek and the Fisher River. DEQ also sampled and assessed Bear Creek for metals impairment. No metals impairment conditions were identified for Bear Creek. All updated assessment results, including removal of all metals impairment causes for Libby Creek and the Fisher River, will be captured within Montana’s 2014 303(d) List.

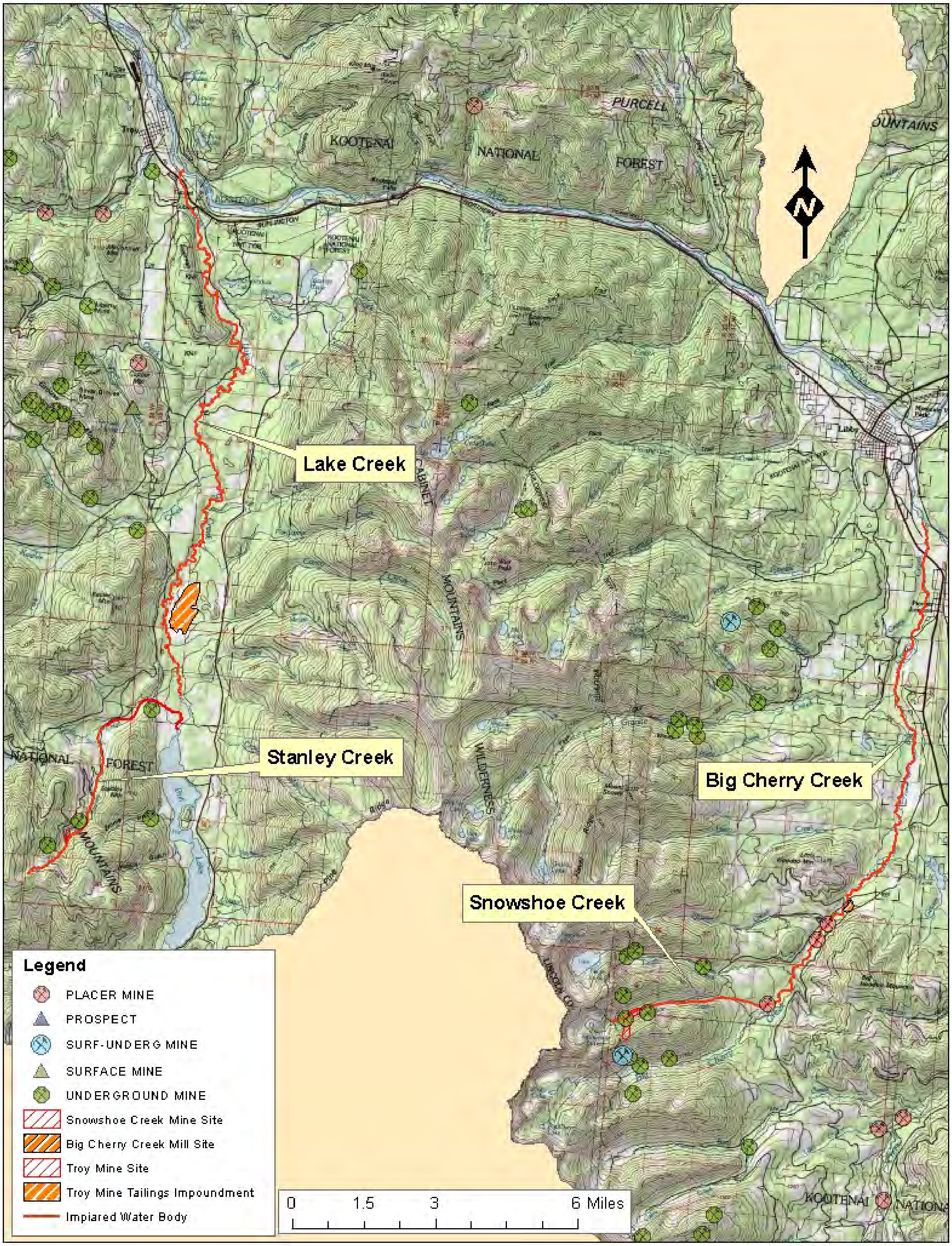

Figure 8-1. Metals Impaired Waterbodies in the Kootenai-Fisher TMDL Project Area

8.3 WATER QUALITY DATA AND INFORMATION SOURCES

The data and information used in this report was obtained from the DEQ Abandoned Mines Program, Montana Bureau of Mines and Geology, U.S.D.A Forest Service, Troy Mine, and DEQ water and sediment quality sampling from 2009-2012.

In accordance with DEQ's data quality objectives guidance (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2013) the data used for impairment assessment and target evaluation are no older than 10 years. Older data are considered descriptive and may be used for source characterization, loading analysis and trend evaluation. In cases where there has been significant cleanup action, data predating the cleanup was not considered.

The DEQ data is the most recent, and provides the basis for the existing condition analyses, TMDLs and allocations in this document. The water and sediment metals data used for analysis in this report is attached in **Appendix F**. Data summaries of relevant water quality and sediment quality parameters for each metals-impaired waterbody segment are provided in **Section 8.4**.

8.4 WATER QUALITY TARGETS AND COMPARISON TO EXISTING CONDITIONS

DEQ compiled the water quality data described in **Section 8.2** for comparison to water quality targets. These targets are established using the most stringent water quality standard, in order to protect all designated uses. **Section 8.4.1** presents the evaluation framework, the metals water quality targets used in the evaluation, and the results of these evaluations for each impaired waterbody.

8.4.1 Metals Evaluation Framework

The metals evaluation process includes:

1. Evaluation of metals sources.
   Metals sources may be both naturally occurring and anthropogenic (i.e. human-caused). TMDLs are developed for waterbodies that do not meet standards, at least in part, due to anthropogenic sources.

2. Development of numeric water quality targets that represent unimpaired water quality (**Section 8.4.2**).
   TMDL plans must include numeric water quality criteria or *targets* that represent a condition that meets Montana's ambient water quality standards. Numeric targets are measurable water quality indicators. They may be used separately or in combination with other targets to represent water quality conditions that comply with Montana's water quality standards (both narrative and numeric). Metals water quality targets are presented in **Section 8.4.2**.

3. Comparison of water quality with water quality targets to determine whether a TMDL is necessary.
   DEQ determines whether a TMDL is required by comparing recent water quality data to metals water quality targets. In cases where one or more targets are not met, a TMDL is developed. If data demonstrates no impairment, each waterbody – impairment cause combination is subsequently removed from the 303(d) list.

8.4.2 Metals Water Quality Targets

Water quality targets for metals-related impairments in the Kootenai-Fisher TMDL Project Area include both water chemistry targets and sediment chemistry targets. The water chemistry targets are based on numeric human health standards and both chronic and acute aquatic life standards as defined in DEQ Circular DEQ-7. Sediment chemistry targets are adopted from numeric screening values for metals in freshwater sediment established by the National Oceanographic and Atmospheric Administration (NOAA).

8.4.2.1 Water Chemistry Targets

Most metals pollutants have numeric water quality criteria defined in Circular DEQ-7 (Montana Department of Environmental Quality, 2008a). These criteria include values for protecting human health and for protecting aquatic life, and apply as water quality standards for all stream segments addressed within this document due to their B-1 classification **(Appendix B)**. Aquatic life criteria include values for both acute and chronic effects. For any given pollutant, the most stringent of these criteria is adopted as the water quality target. Throughout this document, the terms “standard”, “criteria” and “target” are used somewhat interchangeably.

The aquatic life criteria for most metals are dependent upon water hardness values: usually increasing as the hardness increases. Water quality criteria (acute and chronic aquatic life, human health) for each parameter of concern at water hardness values of 25 milligrams per liter (mg/L) and 400 mg/L are shown in **Table 8-1**. These criteria translate into the applicable water quality targets and are expressed in micrograms per liter (ug/L), equivalent to parts per billion. Acute and chronic toxicity aquatic life criteria are intended to protect aquatic life uses, while the human health criteria is intended to protect drinking water uses. Note that arsenic and mercury do not have variable criteria. The acute and chronic criteria are fixed and do not fluctuate with changes in hardness. The chronic and acute aquatic life criteria for zinc are identical for hardness values of 25 mg/L and 400 mg/L and all hardness values in-between.

The evaluation process summarized below is derived from DEQ’s Monitoring and Assessment program guidance for metals assessment methods (Drygas, 2012).

- A waterbody is considered impaired if a single sample exceeds the human health target.
- If more than 10% of the samples exceed the acute or chronic aquatic life target, then the waterbody is considered impaired for that pollutant.
- If both the acute and chronic aquatic life target exceedance rates are equal to or less than 10%, for a given metal, then it is not considered a cause of aquatic life impairment to the waterbody. A minimum 8 samples are required, and samples must represent both high and low flow conditions.
- There are two exceptions to the 10% aquatic life exceedance rate rule: a) if a single sample exceeds the acute aquatic life target by more than a factor of two, the waterbody is considered impaired regardless of the remaining data set; and b) if the exceedance rate is greater than 10% but no anthropogenic metals sources are identified, management is consulted for a case-by-case review.

Table 8-1. Metals numeric water chemistry targets applicable to the Kootenai-Fisher TMDL Project Area

Metal of Concern	Aquatic Life Criteria (µg/L) at 25 mg/L Hardness		Aquatic Life Criteria (µg/L) at 400 mg/L Hardness		Human Health Criteria (ug/L)
	Acute	Chronic	Acute	Chronic	
Arsenic, TR*	340.00	150.00	340.00	150.00	10
Cadmium, TR	0.52	0.10	8.73	0.76	5
Copper, TR	3.79	2.85	51.7	30.5	1,300
Lead, TR	14.0	0.54	477	18.5	15
Mercury, TR	1.70	0.91	1.70	0.91	0.05
Zinc, TR	37.0	37.0	388	388	2,000

*TR = total recoverable

8.4.2.2 Metals Sediment Chemistry Targets

Montana does not currently have numeric water quality criteria for metals in stream sediment, although general water quality prohibitions (ARM 17.30.637) state that *"state surface waters must be free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life".* Stream sediment metals concentrations are used as supplementary indicators of impairment. In addition to directly impairing aquatic life in contact with stream sediments, high metals values in sediment commonly correspond to elevated concentrations of metals in water during high flow conditions. Where instream water quality data exceeds water quality targets, sediment quality data provide supporting information, but is not necessary to verify impairment.

In the absence of numeric criteria for metals in stream sediment, DEQ bases sediment quality targets on values established by the National Oceanic and Atmospheric Administration (NOAA). NOAA has developed Screening Quick Reference Tables for stream sediment quality, including concentration guidelines for metals in freshwater sediments. These criteria come from numerous studies and investigations, and are expressed in Probable Effects Levels (PEL). PELs represent the sediment concentration above which toxic effects to aquatic life frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects data set and the 85th percentile of the no-effect data set (Buchman, 2008). PEL values are therefore used by DEQ as supplemental targets to evaluate whether streams are *"free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life."* If the water quality targets are met but a sediment concentration is more than double the PEL (100% exceedance magnitude), then this result can be used as an indication of a water quality problem and additional sampling may be necessary to fully evaluate target compliance.

Table 8-2 contains the PEL values (in parts per million) for metals of concern in the Kootenai-Fisher TMDL Planning Area.

Table 8-2. Screening level criteria for sediment metals concentrations

Metal of Concern	PEL (mg/kg or parts per million)
Arsenic	17.0
Cadmium	3.53
Copper	197
Lead	91.3
Mercury	0.486
Zinc	315

8.4.3 Existing Conditions and Comparison with Water Quality Targets

For each waterbody segment included in the 2012 Integrated Report for metals (**Table A-1**), DEQ evaluates recent water quality and sediment data relative to the water quality targets to make a TMDL development determination. Many metals impairment determinations were initially based on data collected by the DEQ Abandoned Mines Bureau in the 1990s and may not reflect current conditions. DEQ has recently completed several years of water and stream sediment sampling in the Kootenai-Fisher TMDL project area for the purpose of reassessing the metals impairment determinations. This data provides the basis for the metals target evaluations below.

8.4.3.1 Big Cherry Creek MT76D002_050

Big Cherry Creek is listed in the 2012 Integrated Report as being impaired for zinc. Data compilation, collection and analysis confirm the need for a zinc TMDL and demonstrate the need for cadmium, and lead TMDLs.

Available Water Quality Data

DEQ used recent metals water quality and sediment data to evaluate current conditions relative to water quality targets. Due to the availability of recently-collected water quality data in the watershed, data used were recent 2006 and 2011-2012 synoptic high and low flow sampling data collected by DEQ for subsequent TMDL development support. The water and sediment sample results for those metals exhibiting impairment are compared to water chemistry and sediment targets in **Tables 8-3** and **8-4**.

Table 8-3. Big Cherry Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Lead	Zinc
# Samples	14	14	14
Minimum values (ug/L)	0.29	<0.5	12.8
Maximum Values (ug/L)	01.12	4.2	61.7
# Acute Exceedances	9	0	7
Acute Exceedance Rate	64.3%	0.0%	50.0%
# Chronic Exceedances	14	6	7
Chronic Exceedance Rate	100%	42.9%	50.%
# Human Health Exceedances	0	0	0
Human Health Standard Exceedance Rate	0.0%	0.0%	0.0%

*all units in µg/L are total recoverable fraction

Table 8-4. Big Cherry Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Lead	Zinc
# Samples	2	2	2
Minimum (mg/kg)	2.03	78.9	173
Maximum (mg/kg)	17.8	903	1280
PEL Value (mg/kg)	3.53	91.3	315
# Samples>PEL	1	1	1
PEL Exceedance Rate	50.0%	50.0%	50.0%

*All units in mg/kg are dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Each pollutant is discussed individually. The discussions are summarized below in **Table 8-5**.

Cadmium

Big Cherry Creek was not listed as impaired by cadmium in the 2012 Integrated Report. Recent data collected in 2006 and 2011-2012 established acute and chronic aquatic life (AL) target exceedance rates of 64.3 and 100% respectively. Additionally, one of two sediment samples (50%) was above the PEL. As a result of these exceedances DEQ will add cadmium as a cause of impairment and develop a TMDL for it.

Lead

Big Cherry Creek was not listed as impaired by lead in the 2012 Integrated Report. Recent data collected in 2006 and 2011-2012 indicated that six of 14 water quality samples exceeded the chronic target. The chronic exceedance rate for lead was 42.9%. Additionally, one of two sediment samples (50%) was above the PEL. As a result of these exceedances DEQ will add lead as a cause of impairment and develop a TMDL for it.

Zinc

Big Cherry Creek was listed as impaired by zinc in the 2012 Integrated Report. Data collected in 2006 and 2011-2012 indicated that seven of 14 samples (50%) exceeded both the acute and chronic targets. Additionally, one of two sediment samples (50%) was above the PEL. Because zinc targets were exceeded zinc will remain listed as a cause of impairment to Big Cherry Creek and a TMDL will be developed.

Big Cherry Creek TMDL Development Summary

As discussed above and summarized in **Table 8-5**, cadmium, lead and zinc TMDLs are developed for Big Cherry Creek. These impairment conditions are summarized in **Table 8-5**, and are documented within DEQ's assessment files and will be included in the 2014 Integrated Report.

Table 8-5. Big Cherry Creek Metals TMDL Decision Factors

Parameter	Cadmium	Lead	Zinc
Number of Samples	14	14	14
Chronic AL exceedance rate >10%?	Yes	Yes	Yes
Greater than 2x acute AL target exceeded?	No	No	No
Human Health target exceeded?	No	No	No
2x NOAA PEL exceeded?	Yes	Yes	Yes
Human-caused sources present?	Yes	Yes	Yes
2012 303(d) listed?	No	No	Yes
TMDL developed?	**Yes**	**Yes**	**Yes**

8.4.3.2 Stanley Creek MT76D002_010

Stanley Creek is in the 2012 Integrated Report as impaired by copper. Data compilation, collection and analysis confirm the need for a copper TMDL and demonstrate the need for lead and zinc TMDLs.

Available Water Quality Data

Metals water and sediment quality data were used to compare current conditions to water quality targets. Due to the availability of water quality data in Stanley Creek, data used includes 2005-2012 synoptic high and low flow sampling data collected by the Troy Mine and DEQ for TMDL development support. The water and sediment sample results for those metals exhibiting impairment are compared to water chemistry and sediment targets in **Tables 8-6** and **8-7**.

Table 8-6. Stanley Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Copper	Lead	Zinc
# Samples	38	19	34
Minimum values (ug/L)	<0.5	<0.10	<0.21
Maximum Values (ug/L)	25	10	230
# Acute Exceedances	10	0	1
Acute Exceedance Rate	26.3%	0.00%	2.94%
# Chronic Exceedances	11	3	1
Chronic Exceedance Rate	28.9%	15.8%	2.94%
# Samples >2X the Acute Standard	6	0	1
# Human Health Exceedances	0	0	0
Human Health Standard Exceedance Rate	0.0%	0.0%	0.0%

*all units in µg/L are total recoverable fraction

Table 8-7. Stanley Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Copper	Lead	Zinc
# Samples	1	1	1
Minimum (mg/kg)	215	75	69
Maximum (mg/kg)	215	75	69
PEL Value (mg/kg)	197	91.3	310
# Samples>PEL	1	0	0
PEL Exceedance Rate	100%	0%	0%

*All units in mg/kg are dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Each pollutant is discussed individually. The discussions are summarized below in **Table 8-8**.

Copper

Stanley Creek was listed as impaired by copper in the 2012 Integrated Report. This impairment was originally based upon older sampling from the 1980s and 1990s. Recent (2005-2012) water chemistry data exceeded the acute and chronic aquatic life targets in approximately 26% and 29% of the samples respectively. One sediment sample was collected by DEQ in Stanley Creek and this sample was above the PEL. The copper impairment is retained and a copper TMDL is developed for Stanley Creek.

Lead

Stanley Creek was not listed as impaired by lead in the 2012 Integrated Report. Recent (2005-2012) water chemistry data exceeded the chronic aquatic life target in more than 15% of the samples. Metals concentrations for lead in sediment samples were not above PELs. As a result of the exceedances, DEQ will develop a TMDL for lead and add lead as a cause of impairment to Stanley Creek. DEQ could not use 19 of the samples reported in **Table F-2** in **Appendix F**. These samples were reported as non-detect, with reporting limits that were above the acute aquatic life (AAL), chronic aquatic life (CAL) or Human Health standard. Samples that are reported in this fashion, cannot be accurately compared to a standard, and were therefore left out of the assessment.

Zinc

Stanley Creek was not listed as impaired by Zinc in the 2012 Integrated Report. Recent (2005-2012) water chemistry data exceeded the acute and chronic aquatic life targets in approximately 3% the samples. While these percent exceedances do not typically mandate an impairment listing, one sample was greater than twice the acute aquatic life target. DEQ considered a waterbody impaired if one single sample exceeds the acute aquatic life target (see **Section 8.4.2.1**). Metals concentrations for zinc in sediment samples were not above PELs. As a result of the magnitude of the acute exceedance, DEQ will develop a zinc TMDL and add zinc as a cause of impairment to Stanley Creek.

Stanley Creek TMDL Development Summary

As discussed above and summarized in **Table 8-8**, copper, lead and zinc TMDLs are developed for Stanley Creek.

Table 8-8. Stanley Creek Metals TMDL Decision Factors

Parameter	Copper	Lead	Zinc
Number of Samples	38	19	34
Chronic AL exceedance rate >10%?	Yes	Yes	No
Greater than 2x acute AL target exceeded?	Yes	No	Yes
Human Health target exceeded?	No	No	No
2x NOAA PEL exceeded?	No	No	No
Human-caused sources present?	Yes	Yes	Yes
2012 303(d) listed?	Yes	No	No
TMDL developed?	**Yes**	**Yes**	**Yes**

8.4.3.3. Lake Creek MT76D002_070

Lake Creek is in the 2012 Integrated Report as impaired by metals for cadmium, copper, lead, mercury and zinc. Data compilation, collection and analysis demonstrate the need for copper and lead TMDLs.

Available Water Quality Data

Metals water and sediment quality data were used to compare current conditions to water quality targets. Available water quality data in the Lake Creek watershed includes recent (2011-2012) synoptic high and low flow sampling data collected by DEQ for subsequent TMDL development support as well as data from the Troy Mine from 2005 through 2011. The water and sediment sample results for those metals exhibiting impairment as well as those no longer found to be causing impairment are compared to water chemistry and sediment targets in **Tables 8-9** and **8-10**.

Table 8-9. Lake Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Copper	Lead	Mercury	Zinc
# Samples	24	77	43	12	71
Minimum values (ug/L)	<0.08	<0.5	<0.5	<0.005	<5
Maximum Values (ug/L)	<0.1	49	6	0.0152	10
# Acute Exceedances	0	2	0	0	0
Acute Exceedance Rate	0.00%	2.60	0.00%	0.00%	0.00%
# Chronic Exceedances	0	4	7	0	0
Chronic Exceedance Rate	0.0%	5.19%	16.3%	0.0%	0.0%
# Human Health Exceedance	0	0	0	0	0
Human Health Exceedance Rate	0.0%	0.0%	0.0%	0.0%	0.0%

*all units in µg/L are total recoverable fraction

Table 8-10. Lake Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Copper	Lead	Mercury	Zinc
# Samples	3	3	3	3	3
Minimum (mg/kg)	<0.2	<20	8	<0.05	26
Maximum (mg/kg)	<0.2	21	19	<0.05	52

Table 8-10. Lake Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Copper	Lead	Mercury	Zinc
PEL Value (mg/kg)	3.53	197	91.3	0.486	315
# Samples>PEL	0	0	0	0	0
PEL Exceedance Rate	0.0%	0.0%	0.0%	0.0%	0.0%

*all units in mg/kg are dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Each pollutant is discussed individually. The discussions are summarized below in **Table 8-11**.

Cadmium

Lake Creek was listed as impaired by cadmium in the 2012 Integrated Report. This impairment was originally based upon older sampling from the 1980s and 1990s. Cadmium concentrations in samples recently collected (2005-2012) from Lake Creek did not exceeded the human health, acute or chronic aquatic life targets. Cadmium concentrations in sediment samples were not above PELs. Therefore, DEQ determined that cadmium is not a cause of impairment to Lake Creek, and a TMDL will not be developed for cadmium. Cadmium as a cause of impairment will be removed from the 2014 Integrated Report.

Copper

Lake Creek was listed as impaired by copper in the 2012 Integrated Report. A copper concentration in a sample recently collected (low flow, 2008) from Lake Creek exceeded twice the acute aquatic life target. Therefore, DEQ determined that copper is retained as a cause of impairment to Lake Creek, and a TMDL is developed for copper.

Lead

Lake Creek was listed as impaired by lead in the 2012 Integrated Report. Lead concentrations in samples recently collected (2005-2012) from Lake Creek exceeded the chronic aquatic life target in 16.28% of the samples. Therefore, DEQ determined that lead is retained as a cause of impairment to Lake Creek, and a TMDL is developed for lead.

Mercury

Lake Creek was listed as impaired by mercury in the 2012 Integrated Report. This impairment was originally based upon older sampling from the 1980s and 1990s. Mercury concentrations in samples recently collected (2011-2012) from Lake Creek did not exceeded the human health, acute or chronic aquatic life target. Mercury concentrations in sediment samples were not above PELs. Therefore, DEQ determined that mercury is not a cause of impairment to Lake Creek, and a TMDL will not be developed for mercury. Mercury as a cause of impairment will be removed from the 2014 Integrated Report.

Zinc

Lake Creek was listed as impaired by zinc in the 2012 Integrated Report. This impairment was originally based upon older sampling from the 1980s and 1990s. Zinc concentrations in samples recently collected (2005-2012) from Lake Creek did not exceeded the human health, acute or chronic aquatic life target. Zinc concentrations in sediment samples were not above PELs. Therefore, DEQ determined that zinc is not a cause of impairment to Lake Creek, and a TMDL will not be developed for zinc. Zinc as a cause of impairment will be removed from the 2014 Integrated Report.

Lake Creek TMDL Development Summary

As discussed above and summarized in **Table 8-11**, copper and lead TMDLs are developed for Lake Creek. DEQ concluded that cadmium, mercury and zinc no longer contribute to impairment on Lake Creek. This non-impairment condition, also summarized in **Table 8-11**, is documented within DEQ's assessment files and will be included in the 2014 Integrated Report.

Table 8-11. Lake Creek Metals TMDL Decision Factors

Parameter	Cadmium	Copper	Lead	Mercury	Zinc
Number of Samples	24	77	43	12	71
Chronic AL exceedance rate >10%?	No	No	Yes	No	No
Greater than 2x acute AL target exceeded?	No	Yes	No	No	No
Human Health target exceeded?	No	No	No	No	No
2x NOAA PEL exceeded?	No	No	No	No	No
Human-caused sources present?	Yes	Yes	Yes	Yes	Yes
2012 303(d) listed?	Yes	Yes	Yes	Yes	Yes
TMDL developed?	**No**	**Yes**	**Yes**	**No**	**No**

8.4.3.4. Snowshoe Creek MT76D002_040

Snowshoe Creek is in the 2012 Integrated Report as impaired by metals for cadmium and zinc. Data compilation, collection and analysis confirm the need for arsenic and lead TMDLs as well as demonstrate the need for cadmium and zinc TMDLs.

Available Water Quality Data

DEQ used recent metals water quality to evaluate current conditions relative to water quality targets. Due to the availability of recently-collected water quality data in the watershed, data used were recent 2011-2012 synoptic high and low flow sampling data collected by DEQ for subsequent TMDL development support. The water sample results are compared to water chemistry targets in **Tables 8-12**. No sediment samples were collected in Snowshoe Creek.

Table 8-12. Snowshoe Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Lead	Zinc
# Samples	9	9	9	9
Minimum values (ug/L)	<3	<0.08	<0.5	<10
Maximum Values (ug/L)	13	7.03	27.9	480
# Acute Exceedances	0	7	2	7
Acute Exceedance Rate	0.00%	77.8%	22.2%	77.8%
# Chronic Exceedances	0	7	8	7
Chronic Exceedance Rate	0.0%	77.8%	88.9%	77.8%
# Human Health Exceedance	1	3	3	0
Human Health Exceedance Rate	11.1%	33.3%	33.3%	0.0%

*all units in µg/L; total recoverable fraction

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Each pollutant is discussed individually. The discussions are summarized below in **Table 8-13**.

<u>Arsenic</u>

Arsenic concentrations in samples recently collected (2011-2012) from Snowshoe Creek exceeded the human health target in one water sample. DEQ considers a waterbody impaired if one single sample exceeds the human health target (see **Section 8.4.2.1**). Therefore, DEQ determined that arsenic will be addressed as a cause of impairment to Snowshoe Creek, and a TMDL is developed for arsenic.

<u>Cadmium</u>
Snowshoe Creek was listed as impaired by cadmium in the 2012 Integrated Report. Cadmium concentrations in samples recently collected (2011-2012) from Snowshoe Creek exceeded the acute and chronic aquatic life target in 77.8% of the samples for each target. Cadmium concentrations were also above the human health target in 33.3% of the samples. Therefore, DEQ determined that cadmium is a cause of impairment to Snowshoe Creek, and a TMDL is developed for cadmium.

<u>Lead</u>
Snowshoe Creek was listed as impaired by lead in the 2012 Integrated Report. Lead concentrations in samples recently collected (2011-2012) from Snowshoe Creek exceeded the acute and chronic aquatic life target in 22.2% and 88.9% of the samples respectively. Lead concentrations were also above the human health target in 33.3% of the samples. Therefore, DEQ determined that lead is retained as a cause of impairment to Snowshoe Creek, and a TMDL is developed for lead.

<u>Zinc</u>
Zinc concentrations in samples recently collected (2011-2012) from Snowshoe Creek exceeded the acute and chronic aquatic life target in 77.8% of the samples for each target. Therefore, DEQ determined that zinc is added as a cause of impairment to Snowshoe Creek, and a TMDL is developed for zinc.

Snowshoe Creek TMDL Development Summary
As discussed above and summarized in **Table 8-13**, arsenic, cadmium, lead and zinc TMDLs are developed for Snowshoe Creek.. These impairment conditions, also summarized in **Table 8-13**, are documented within DEQ's assessment files and will be included in the 2014 Integrated Report.

Table 8-13. Snowshoe Creek Metals TMDL Decision Factors

Parameter	Arsenic	Cadmium	Lead	Zinc
Number of Samples	9	9	9	9
Chronic AL exceedance rate >10%?	No	Yes	Yes	Yes
Greater than 2x acute AL target exceeded?	No	Yes	No	Yes
Human Health target exceeded?	Yes	Yes	Yes	No
2x NOAA PEL exceeded*	N/A	N/A	N/A	N/A
Human-caused sources present?	Yes	Yes	Yes	Yes
2012 303(d) listed?	No	Yes	No	Yes
TMDL developed?	**Yes**	**Yes**	**Yes**	**Yes**

* No metals data collected in Snowshoe Creek

8.4.4 Metals Target Comparison and TMDL Development Summary

Based on the updated metals assessment and target comparison results summarized above, 12 metals TMDLs will be developed for four waterbodies in the Kootenai – Fisher project area. These are identified in **Table 8-14**. **Table 8-14** also identifies those metals impairment causes identified on the 2012 303(d) List but subsequently concluded as not causing impairment based on the updated assessments. As previously noted, no TMDLs are required for Libby Creek and the Fisher River because the updated assessment information revealed no metals impairment conditions. All updated assessment results captured within **Table 8-14** will be incorporated within the 2014 303(d) List and associated 2014 Integrated Report.

Reassessment of metals impairment causes in Libby Creek, Fisher River and Lake Creek found that concentrations are within target values for the majority of the metals impairment causes identified in the 2012 Integrated Report. There are two exceptions: copper and lead in Lake Creek. These impairment causes were confirmed and will be retained for the 2014 Integrated Report. The impairment causes for the Fisher River (lead), Libby Creek (mercury) and Lake Creek (cadmium, mercury and zinc) will be removed from the 2014 Integrated Report.

Reassessment of metals impairment causes in Big Cherry, Snowshoe and Stanley Creek confirmed all of the metals impairments on the 2012 Integrated Report. In addition to these confirmations several additional pollutants were identified. In Big Cherry Creek cadmium and lead were identified as impairments, in Snowshoe Creek arsenic and lead were identified, and in Stanley Creek lead and zinc were identified as impairments.

During the recent sampling and analysis process, DEQ sampled Bear Creek for the first time. During this assessment, DEQ sampled for a full metals suite, and determined that Bear Creek was not impaired for any of the metals sampled.

Table 8-14. Updated Metals Assessment Results and TMDLs Developed for the Kootenai - Fisher TMDL Project Area

Waterbody & Location Description	Waterbody ID	Metal Pollutant	Listed as Impaired on 2012 303(d) List	Updated Impairment Determination	TMDL Developed
Fisher River, (Silver Butte/Pleasant Valley Junction to Kootenai River)	MT76C001_010	Lead	Yes	Not Impaired	No
Lake Creek, (Bull Lake outlet to Kootenai River)	MT76D002_070	Cadmium	Yes	Not Impaired	No
		Copper	Yes	Impaired	Yes
		Lead	Yes	Impaired	Yes
		Mercury	Yes	Not Impaired	No
		Zinc	Yes	Not Impaired	No
Big Cherry Creek, (Snowshoe Creek to Libby Creek)	MT76D002_050	Cadmium	No	Impaired	Yes
		Lead	No	Impaired	Yes
		Zinc	Yes	Impaired	Yes
Libby Creek,(1 mile above Howard Creek to HWY 2 bridge)	MT76D002_061	Mercury	Yes	Not Impaired	No
Snowshoe Creek, (Cabinet Wilderness Boundary to Big Cherry Creek)	MT76D002_040	Arsenic	No	Impaired	Yes
		Cadmium	Yes	Impaired	Yes
		Lead	No	Impaired	Yes
		Zinc	Yes	Impaired	Yes
Stanley Creek, (Headwaters to mouth, (Lake Creek))	MT76D002_010	Copper	Yes	Impaired	Yes
		Lead	No	Impaired	Yes
		Zinc	No	Impaired	Yes

8.5 METALS SOURCE ASSESSMENTS

Identified metals sources linked to human activity are primarily related to Montana's mining legacy: abandoned and inactive hard rock mines. These metals sources include adits and seeps, metals-laden floodplain deposits, waste rock and tailings, and other features associated with abandoned and inactive mining operations. There is also MPDES-permitted storm water discharges in the Kootenai-Fisher project area. Permitted storm water discharges are those that discharge stormwater runoff to a state waterbody. The specific sources identified in each watershed are described below.

8.5.1 Big Cherry Creek MT76D002_050

The major metals source identified in the Big Cherry Creek watershed is an abandoned/inactive mill site on Montana's list of priority abandoned mine cleanup sites. This site is known as the Big Cherry Creek mill site. Waste rock, tailings and by-products of the mining and milling processes are present in and around the mill site. The volume of tailing associated with this site has been estimated to be approximately 4,540 cubic yards. Tailings have been reclaimed, and are mostly vegetated (**Section 2.3.5**). Site investigations in the early 1990s discovered levels of metals in onsite tailings that were three times background concentrations. Metals parameters that were above background include arsenic, cadmium, copper, lead, antimony, zinc and mercury (Pioneer Technical Services, Inc., 1995).

Other potential contributing sources include abandoned mines identified by DEQ and the Montana Bureau of Mines and Geology (MBMG). These include the underground lode mines of the Copper Reward, Seattle, Silver Tip and Fairbault Mines. These mines are located in the headwaters of Big Cherry Creek. Additional contributing sources include the Leigh Creek, Big Sky and Missouri lode mines. These mines are in the Leigh Creek watershed. Leigh Creek flows into Big Cherry downstream of the confluence with Snowshoe Creek. DEQ and MBMG also identified a number of small scale placer operations on Big Cherry Creek up stream of the mill site.

The original metals impairment listings for Big Cherry Creek were based primarily on water quality samples collected in 1999 for the DEQ Water Quality Standards Attainment Record. DEQ completed additional stream sampling in 2006 and from 2011-2012 to use for updated assessment and to support subsequent TMDL development (**Appendix F**).

Figure 8-2 shows the location of the Big Cherry Creek mill site, the placer operations and DEQ's sample locations.

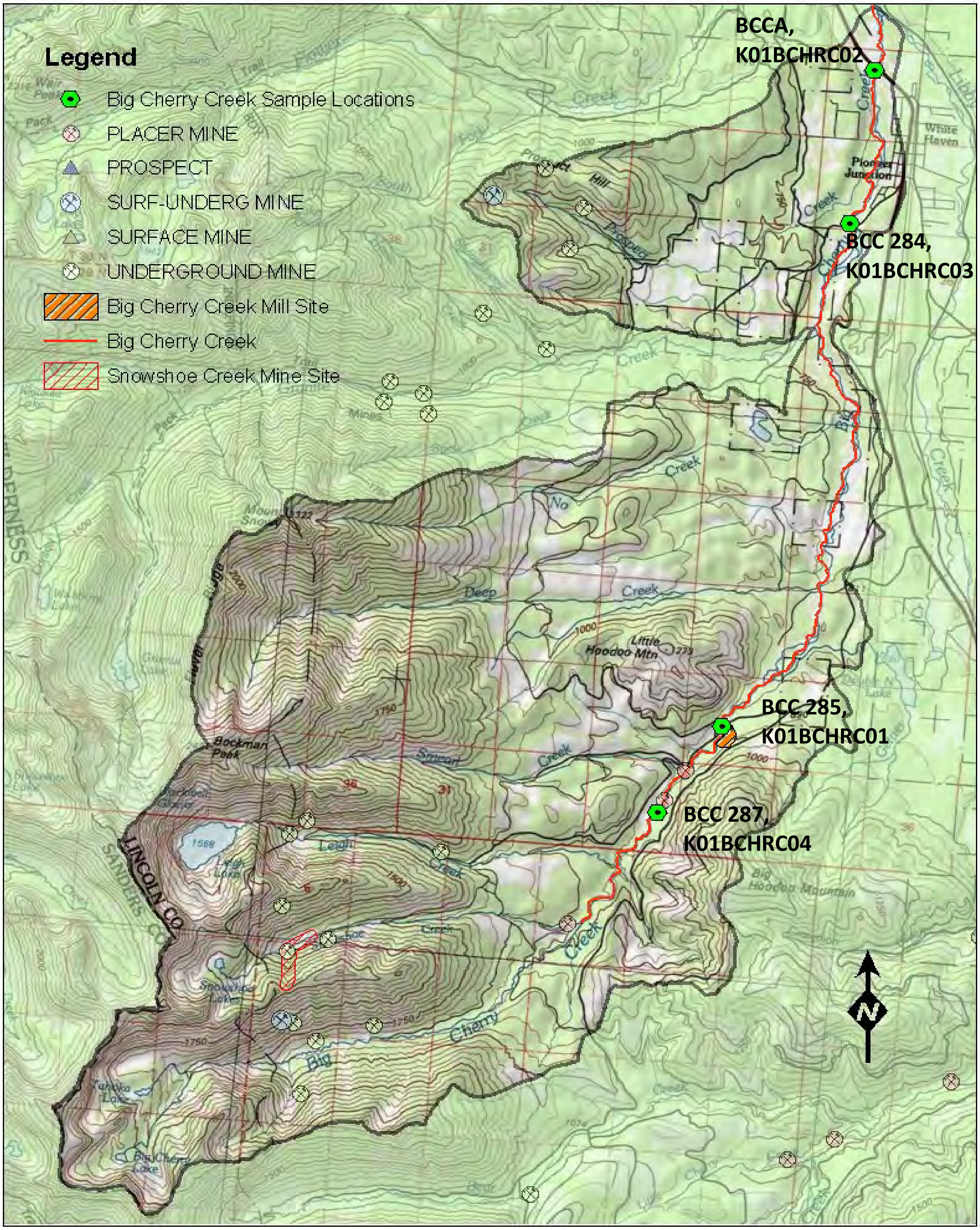

Figure 8-2. Metals sources and sample locations in the Big Cherry Creek watershed

Cadmium, concentrations were consistently above acute aquatic life (AAL) and chronic aquatic life (CAL) criteria in water samples collected above and below the Big Cherry Creek Mill site. Cadmium exceeded the CAL in 100% of the samples collected. The AAL value was exceeded in 64.3% of the samples. Lead was detected above and below the Mill site as well. The lead CAL was exceeded in 42.9% of the samples. No AAL was exceeded. Zinc was in exceedance for both the AAL and CAL. As the AAL and CAL criteria for zinc are the same, exceedance rates are the same. Both the AAL and CAL were exceeded in 50.0% of the samples collected **(Appendix F).**The aforementioned exceedance rates are for all sampling locations upstream and downstream of the Big Cherry Creek Mill site.

While the Mill site is the most probable source of pollution in the lower segments of the watershed, concentrations of all impaired metals (Cd, Pb, Zn) were significantly higher at upstream sample locations. This suggests significant metals loading from those sources above the Mill site. This includes tributary loading from the head waters of Snowshoe Creek, Leigh Creek and Snowshoe Creek. The tributary of Snow shoe Creek is a significant source, loading metals associated with the Snowshoe Mine and Snowshoe Mine tailings deposits in Snowshoe Creek. While concentrations remain highest at the sampling locations above and immediately downstream of the Mill site, they gradually decrease at downstream monitoring sites.

8.5.2 Stanley Creek MT76D002_010

The major metals source identified in the Stanley Creek watershed are most likely those associated the active Troy Mine and with other historical mining activities.

The highest water quality metals concentrations observed were associated with high flow samples, suggesting that metals are bound in the sediment and only become mobile when there is a significant disturbance (high flow events). As such, metals pollution in Stanley Creek is likely associated with sediment production. There are a number of events that have taken place in the last 10-20 years that have contributed metals laden sediment to Stanley Creek.

The upper Stanley Creek watershed has three tributary streams. Below Troy Mine's west ventilation adit, the middle tributary of Stanley Creek was once partially buried by coarse rock, which was sidecast during the initial mine development. Stanley Creek now flows through a culvert onto the talus slope and flows about 200 feet down to the original stream channel. The stream channel area is unvegetated for approximately another 200 feet below the toe of the sidecast material. While some erosion may be occurring along the unvegetated steep slope adjacent to the sidecast area, this site overall is probably a minor source of sediment to Stanley Creek (U.S. Forest Service and Montana Department of Environmental Quality, 2012). That being said, water quality samples collected upstream and downstream of the sidecast area during a July 2012 Hard Rock Program Operating Permit field inspection showed elevated copper concentration. The upstream sample was reported as 0.004 mg/L, and increased to 0.006 mg/L downstream of the sidecast area. Both samples were above the chronic aquatic life standard. Soils samples collected during the inspection from the sidecasting area contained elevated concentrations of copper, lead, and antimony.

In 1996, a slump occurred in the fillslope on NFSR 4626 between the mill site and the North Portal area resulting in a debris avalanche that buried approximately 200 feet of upper Stanley Creek with landslide debris. After reaching Stanley Creek, the slide became a debris torrent that caused major scour and sediment deposition down to the Creek's confluence with Fairway Creek. Sediment deposited during this event is still evident throughout upper Stanley Creek and is a chronic source of sediment during peak flow events. It is likely that much of the sediment resulting from the 1996 slope failure is now deposited in lower Stanley Creek (U.S. Forest Service and Montana Department of Environmental Quality, 2012).

In October of 2009, a leak in a tailings pipeline spilled tailings into Thicket Creek (a tributary to Stanley Creek) about 150 feet above its confluence with lower Stanley Creek. Approximately 40 tons of tailings solids flowed out of the pipeline during the course of the spill and much of this material settled in Thicket and Stanley Creeks as a layer of cohesive silt. Some of the material was suspended in the stream and carried down to Lake Creek. Cleanup operations removed most of the tailings from Thicket Creek. Difficult access and high water velocities made it impossible to remove most of the tailings that had reached Stanley Creek. Tailings are presently visible in the slower water areas downstream from the confluence with Thicket Creek (U.S. Forest Service and Montana Department of Environmental Quality, 2012). In October of 2011 another tailings pipeline spill occurred in Thicket Creek. Again tailings flowed down Thicket Creek and were deposited in Stanley Creek. Tailings deposits in Stanley Creek were visibly larger than those observed during the 2009 spill, as noted in the October 26, 2011 DEQ Hard Rock Program Operating Permit Field Inspection Report. Water quality data collected at the time of the inspection indicated levels of copper in exceedance of the chronic aquatic life standard. Total recoverable copper was reported at 0.017 mg/L, at a hardness of 86 mg/L.

There are also two underground lode mines that are within the Stanley Creek watershed. These are the Daniel Lee Lode Mine, Blue Bird Mine. USFS forest maps indicate unnamed mines on Mount Vernon within the Stanley Creek watershed. **Figure 8-3** shows the spatial extent of historic mining activity and mine wastes in the Stanley Creek watershed.

The only active MPDES surface water permit (permit # MTB004212) is issued to Troy Mine Inc. This permit is a temporary permit issued to control turbidity only. There is no anticipated discharge of metals polluted wastewater associated with this permit, as such no wasteload allocations (WLA) will be assigned to the discharge associated with this permit.

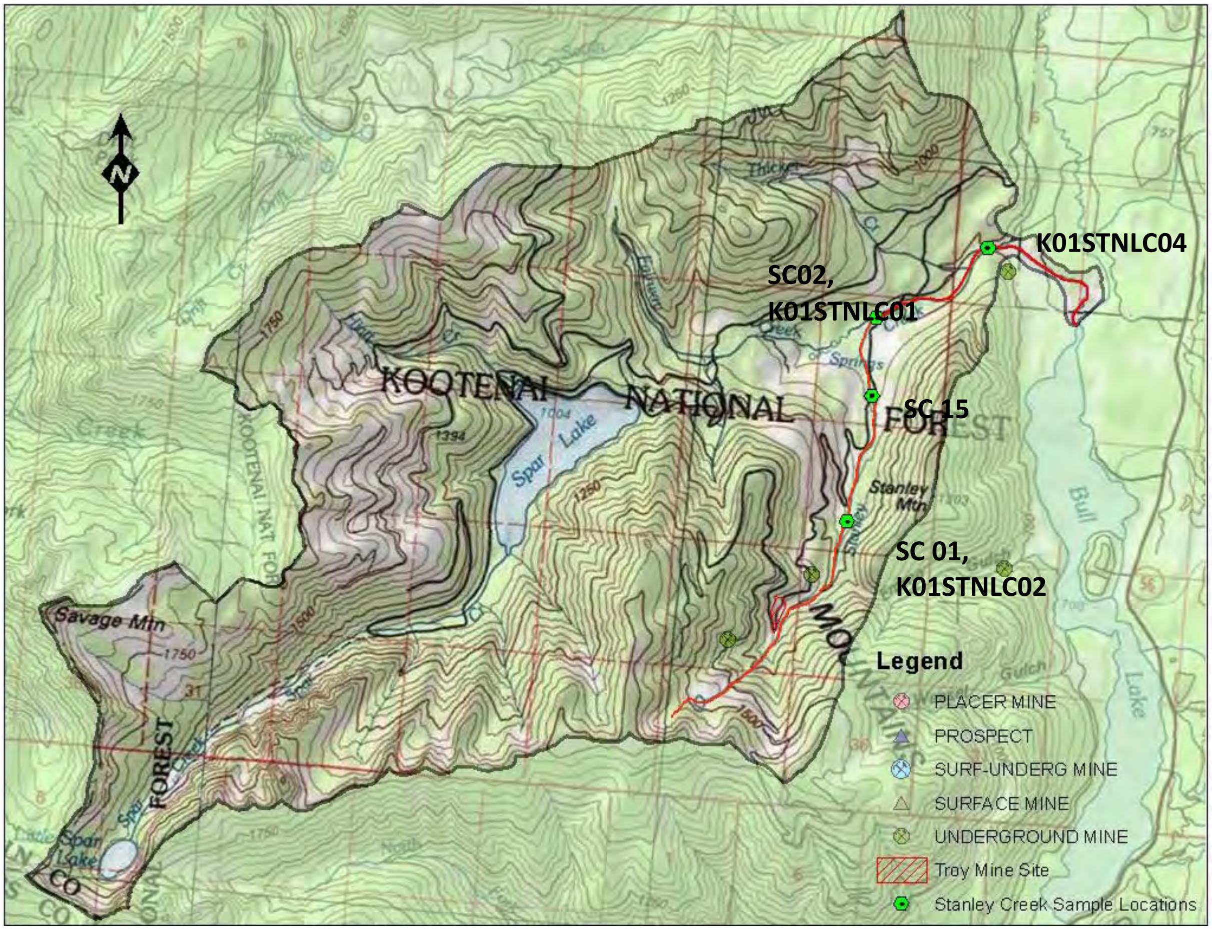

Figure 8-3. Metals sources and sample locations in the Stanley Creek watershed

The Troy Mine water quality data from 2005-2011, and DEQ stream sampling data from 2011-2012 was used for an updated assessment and to support subsequent TMDL development **(Appendix F)**. Copper, concentrations were consistently above acute aquatic life (AAL) and chronic aquatic life (CAL) criteria in water samples collected in Stanley Creek. Copper exceeded the AAL in 26% of the samples collected. The CAL value was exceeded in 29% of the samples. Lead was also a cause of impairment. The CAL for lead was exceeded in 16% of the samples. No AAL was exceeded for lead.

The Troy mine submitted data from several sampling locations. The data submitted by the mine was used in TMDL development however the data did not include latitude and longitude data. As a result the monitoring locations could not be mapped. This includes monitoring locations SC15, SC15-B, SC17-A and SC02. These monitoring locations are included in **Appendix F**, but not included in **Figure 8-3**.

8.5.3 Lake Creek MT76D002_070

Figure 8-4 shows the spatial extent of historic mining activity and mine wastes in the Lake Creek watershed. Mining-related metals sources were studied in a variety of investigation and remediation activities. These projects documented metals contamination of soil, surface water and stream sediments. Most of this work was completed by the Troy Mine (or its consultants) at the request of DEQ. Of particular interest, is the mine related investigation completed for the Troy Mine tailings impoundment adjacent to Lake Creek (U.S. Forest Service and Montana Department of Environmental Quality, 2012; Genesis, Inc., 2006; Summit Envirosolutions, 1996; 1999). Potential sources of metals pollution to Lake Creek include the aforementioned tailings pond adjacent to Lake Creek, contributions from tributaries to Lake Creek that have seen historical mining, as well as historical and active mining in Stanley Creek.

MBMG and DEQ have identified a number of abandoned underground lode mines in various states of operation (past producing mines, developed deposits and prospects) in some of the tributaries to Lake Creek. One sub-watershed with a particularly high density of mining activity is the North Fork of Keeler Creek. The North Fork of Keeler Creek flows into Keeler Creek which in turn flows into Lake Creek. MBMG and DEQ has identified operations including the Grouse Mountain, Silver Strike, Little Spokane, Silver King, Cabinet Queen Prospect, Hiawatha, Universal, Iron Mask, Bimetalic/Black Horse and Last Chance mining operations.

Another tributary to Lake Creek that has had a significant mining presence includes Copper Creek. Past mining operations on Copper Creek include the underground lode mines of: Giant Sunrise, Crescent Tunnel, Liberty Metals, American Eagle, Montana Morning and Lost Cause. Surface mining operations include the Barite Prospect and the Montana Premier Mine. Placer mining operations include the Kotschevar Barite mine. Copper Creek is a direct tributary to Lake Creek and joins the mainstem of Lake Creek approximately 5 miles upstream of the confluence with the Kootenai River. Along with these identified abandoned mines, there are likely other unidentified abandoned mines and waste rock piles acting as contributing sources.

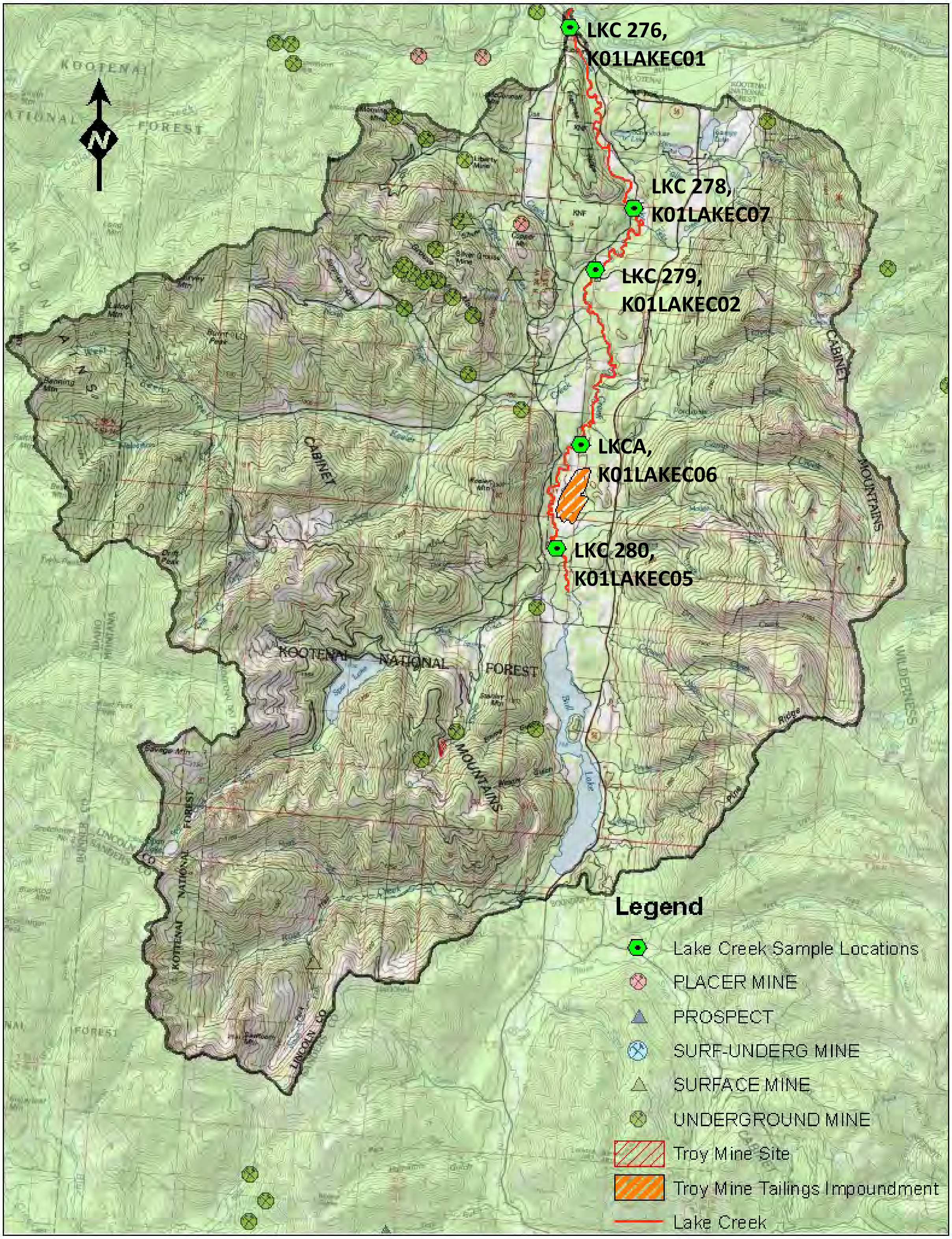

Figure 8-4. Metals sources and sampling locations in the Lake Creek watershed

The Troy Mine maintains a large tailings impoundment that is adjacent to Lake Creek, and Camp Creek, about 1000 feet downstream of the confluence of the two. The tailings impoundment is approximately 430 acres of disturbed area (Genesis, Inc., 2006). The impoundments receive several tons of slurried mine tailings daily when the mine is in operation (Jepson, Wayne, personal communication 04/15/2013). The tailings impoundment is comprised of 3 unlined cells. The tailing site incorporates several toe ponds that collect seepage from the impoundments. Water in the toe ponds is a mixture of groundwater, impoundment seepage, and surface runoff. Standing water from these ponds is periodically pumped back into the impoundments. There are also several smaller decant ponds that receive stormwater runoff from the impoundment site. The mine observes natural attenuation of copper and other metals through natural geochemical processes within the impoundments (Hydrometrics, Inc., 2010). Groundwater data from monitoring wells indicate limited metals pollution as a result of tailings pond seepage.

Troy Mine data from 2005-2011 and DEQ stream sampling from 2009-2011 were used for an updated assessment and to support subsequent TMDL development (**Appendix F**). Copper concentrations in a low-flow, sample collected at monitoring location LC02 exceeded twice the AAL standard. Lead concentrations in samples from Lake Creek exceeded the CAL standard in 16% of the samples. While the concentrations of copper and lead sample results indicate continued impairment, cadmium and zinc sample results indicated continued listing of these metals was not necessary.

The majority of the water quality data from Lake Creek was reported as non-detect. However there were exceedances of target values for both copper and lead as previously indicated. There were no lead or copper concentrations above non-detect in the sample location upstream of the tailings impoundment. Copper had one sample that was in exceedance of the target and one at the detection limit at the sampling locations downstream of the tailings impoundment.

The highest concentrations of metals occurred at those sampling sites downstream of the tailing impoundment, during high runoff events. These high concentrations are an effect of metals entrainment during high runoff events. The entrainment and resulting metals loading to Stanley Creek is related to the ongoing and historical mining activity that has taken place throughout the watershed.

The Troy mine submitted data from several sampling locations. The data submitted by the mine was used in TMDL development however the data did not include latitude and longitude data. As a result the monitoring locations could not be mapped. This includes monitoring locations LC01, LC02, LC03 and LC04. These monitoring location are included in **Appendix F** and not identified on **Figure 8-4**.

8.5.4 Snowshoe Creek MT76D002_040

Several agencies, including DEQ, MBMG, and the USFS, have studied mining-related metals sources in the Snowshoe Creek watershed (Maxim Technologies, Inc., 2004; Pioneer Technical Services, Inc., 1994; Hargrave et al., 1999b; Pioneer Technical Services, Inc., 2010). These projects documented metals contamination of soil, groundwater, surface water and stream sediments. **Figure 8-5** shows the spatial extent of historic mining activity and mine wastes in the watershed. DEQ completed additional stream sampling from 2011-2012. This data was used to update the stream assessment and to support subsequent TMDL development (**Appendix F**).

Anthropogenic metals sources in the Snowshoe Creek watershed are related primarily to the reclaimed Snowshoe Mine and Mill Site (collectively referred to as the Snowshoe Mine) and associated workings, as well as intact, instream tailing deposits downstream of the mine site. Other potential contributing sources include those abandoned mines identified by DEQ and the Montana Bureau of Mines and Geology (MBMG). These include the underground lode mines of the Texas Ranger and St. Paul Mines. These mines are located in the headwaters of Snowshoe Creek.

The Snowshoe Mine site was identified on the Montana list of priority abandoned mine cleanup sites. Reclamation activities started in 2007 and were completed in 2012. Reclamation activities were focused on U.S Department of Agriculture Forest Service (USFS) land which comprises the mine and mill sites. No reclamation efforts were directed to in stream mine tailings deposits downstream of the mine and mill sites.

The major source of metals in Snowshoe Creek is mine waste in the stream bed and in the floodplain. Maxim 2004 describes a stream reach downstream of the reclaimed mine site that contained a very long stretch of mine tailing deposits (8 feet high by 300 feet long) consisting of loose crushed ore that makes up the streambank. Streambank soil samples exhibited arsenic, cadmium, lead and zinc concentrations three orders of magnitude higher than PELs, although the PELs do not apply as TMDL targets for streambank soils. Also cadmium, lead and zinc concentrations two orders of magnitude higher than CAL standards in water quality samples.

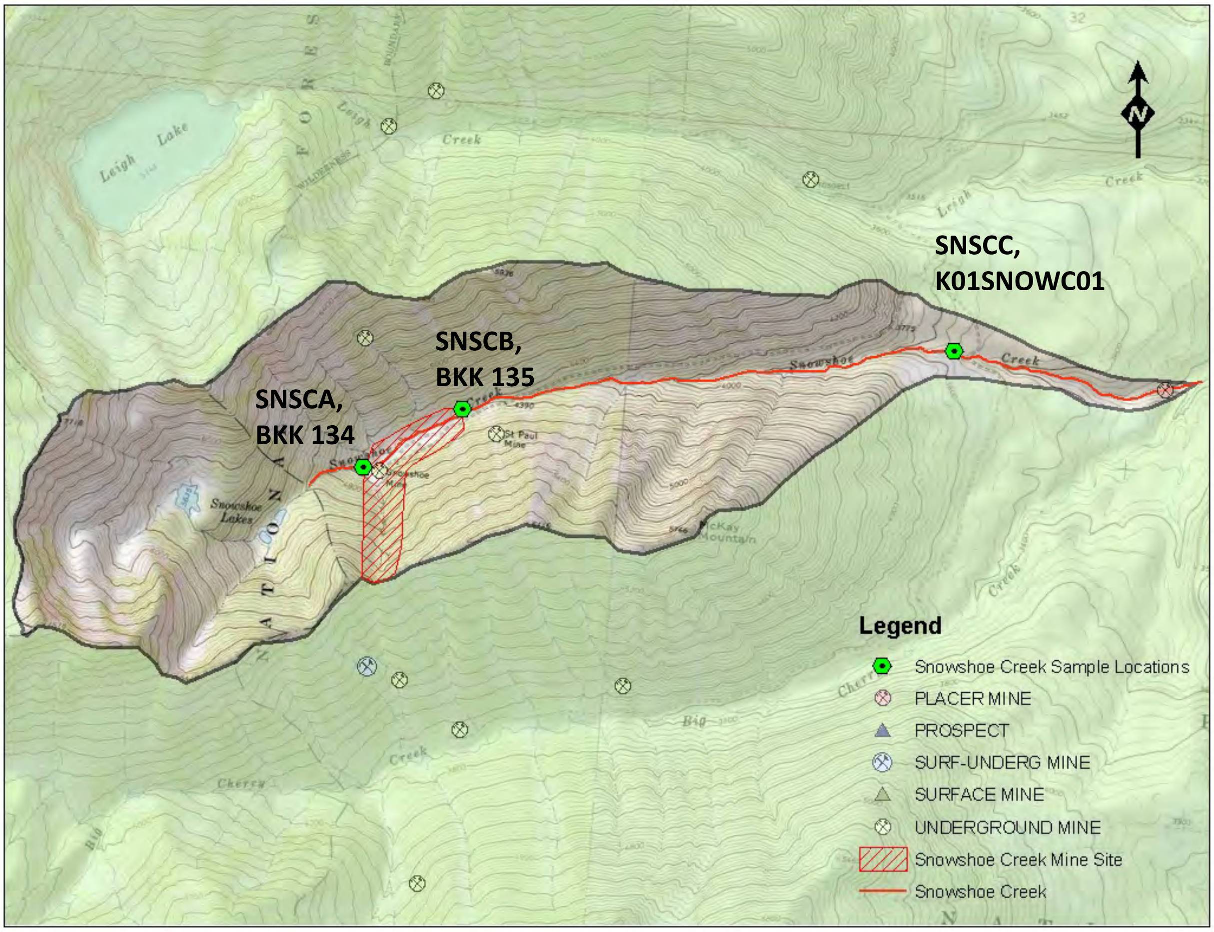

Figure 8-5. Metals sources and sampling locations in the Snowshoe Creek watershed

DEQ collected water samples from Snowshoe Creek from 2011-2012. Data from these samples is provided in **Appendix F**. The highest metals concentrations in Snowshoe Creek occur at monitoring locations SNSCB, BKK 135, SNSCC and K01SNOWC01. The highest concentrations for all metals occur at monitoring location SNSCC and K01SNOWC01. The mine waste in the stream bed and in the floodplain occurs between monitoring locations SNSCB, BKK 135 (immediately downstream of the mine site) and monitoring locations SNSCC and K01SNOWC01 (Downstream of the streamside tailings). Given these high concentrations at these locations, it is likely the source of metals is the Snowshoe Mine site and the existing streamside tailings deposits.

8.6 METALS TMDLS AND ALLOCATIONS

8.6.1 Metals TMDLs

This section presents metals TMDLs for impaired waterbodies in the Kootenai-Fisher TMDL Project Area. TMDLs are based on the most stringent water quality criteria or the water quality target, the water hardness if applicable, and the streamflow. Target development is discussed in detail above, in **Section 8.4.2.1**.

Because streamflow and hardness vary seasonally, the TMDL is not expressed as a static value, but as an equation of the appropriate target multiplied by flow. These equations are illustrated below in **Figures 8-6** through **8-10**. The TMDL under a specific flow condition is calculated using the following formula:

TMDL = (X) (Y) (k)

TMDL= Total Maximum Daily Load in lbs/day
X= lowest applicable metals water quality target in µg/L
Y= streamflow in cubic feet per second
k = conversion factor of 0.0054

Four metals impairment causes in the Kootenai -Fisher project area have standards for protection of aquatic life that vary according to water hardness as defined within DEQ-7 (Montana Department of Environmental Quality, 2012a). Generally aquatic life standards become more stringent as water hardness decreases. Water hardness may vary seasonally, and instream water hardness is commonly higher under low flow conditions. For calculating example TMDLs in this section, the lowest applicable metals water quality target is based upon the measured hardness corresponding to that sample. In those cases where the human health standard is the lowest target, those values are used. This is the case with arsenic in Snowshoe Creek.

Figure 8-6 is a plot showing TMDLs versus flow for impairment causes that are not influenced by hardness. **Figures 8-7** through **8-10** show TMDLs versus flow for the hardness-dependent impairment causes at hardness conditions of 25mg/L and 400/mg/L. These values represent the complete range of variability of hardness per DEQ-7, as well as the naturally occurring conditions in the Kootenai-Fisher project area (**Appendix F**). Although a 10% target exceedance rate is allowed for aquatic life targets, the TMDLs are set so that these targets are satisfied 100% of the time. This provides a margin of safety by focusing remediation and restoration efforts toward 100% compliance to the extent practical.

The TMDL equation and curves apply to all metals TMDLs within this document and describe TMDLs for each metal under variable flow and hardness conditions. Metals TMDLs apply to any point along the waterbody and therefore protect uses along the entire stream. An exception may be found in a mixing zone established for a National Pollutant Discharge Elimination System (NPDES) permitted discharge.

However this does not apply within the Kootenai-Fisher TMDL project area since there are no permitted discharges with mixing zones.

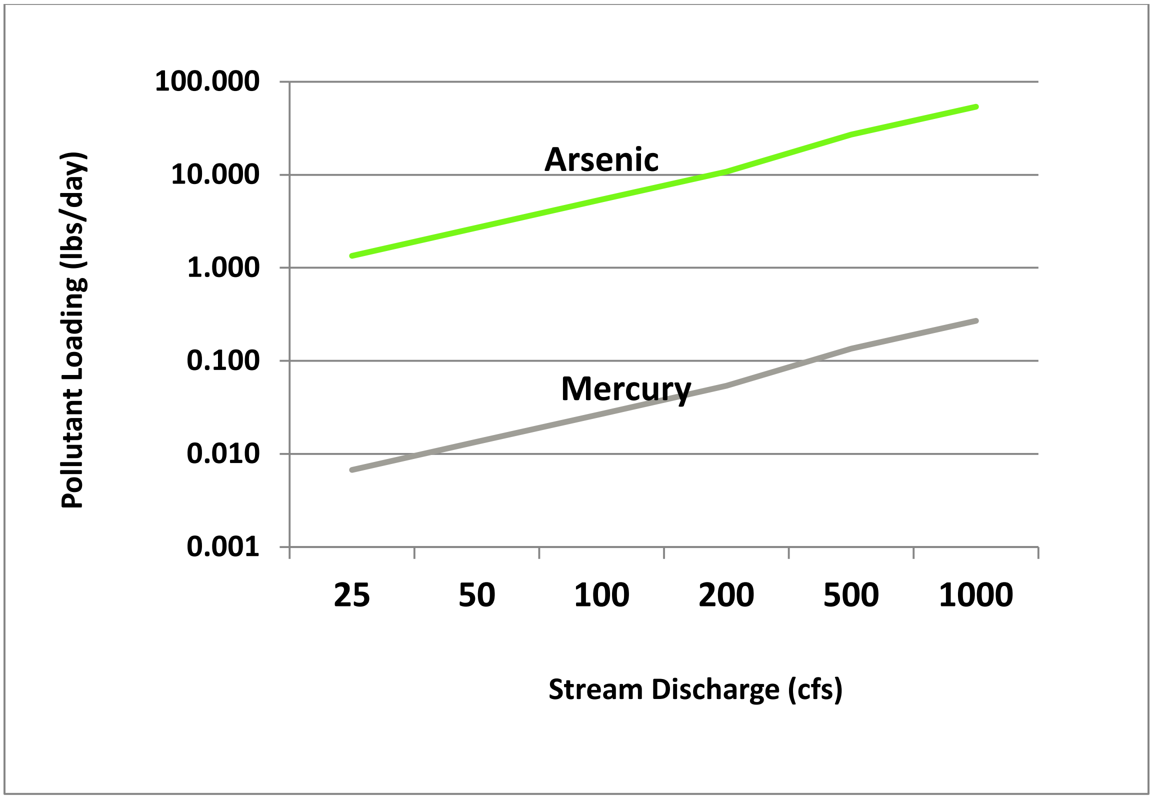

Figure 8-6. Hardness-independent metals TMDLs as functions of flow

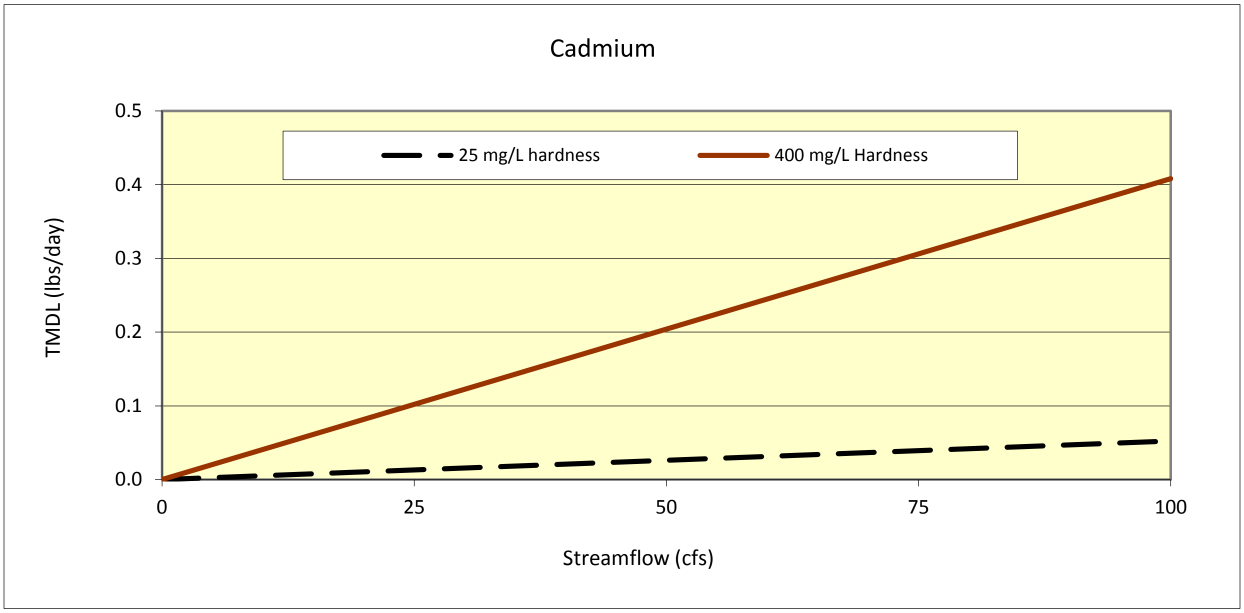

Figure 8-7. Cadmium TMDL as a function of flow

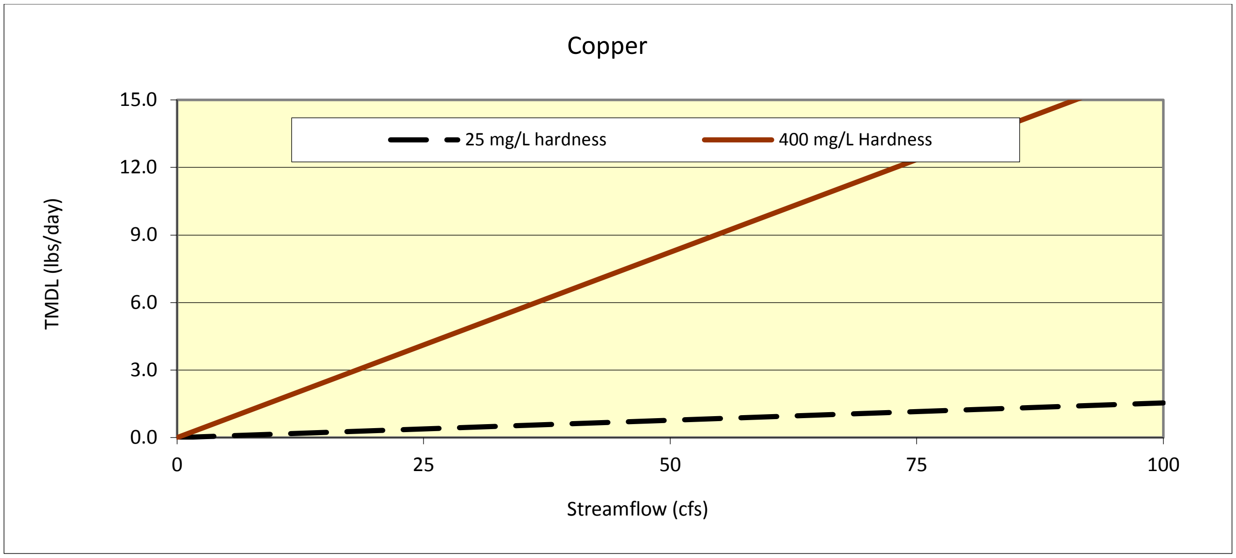

Figure 8-8. Copper TMDL as a function of flow

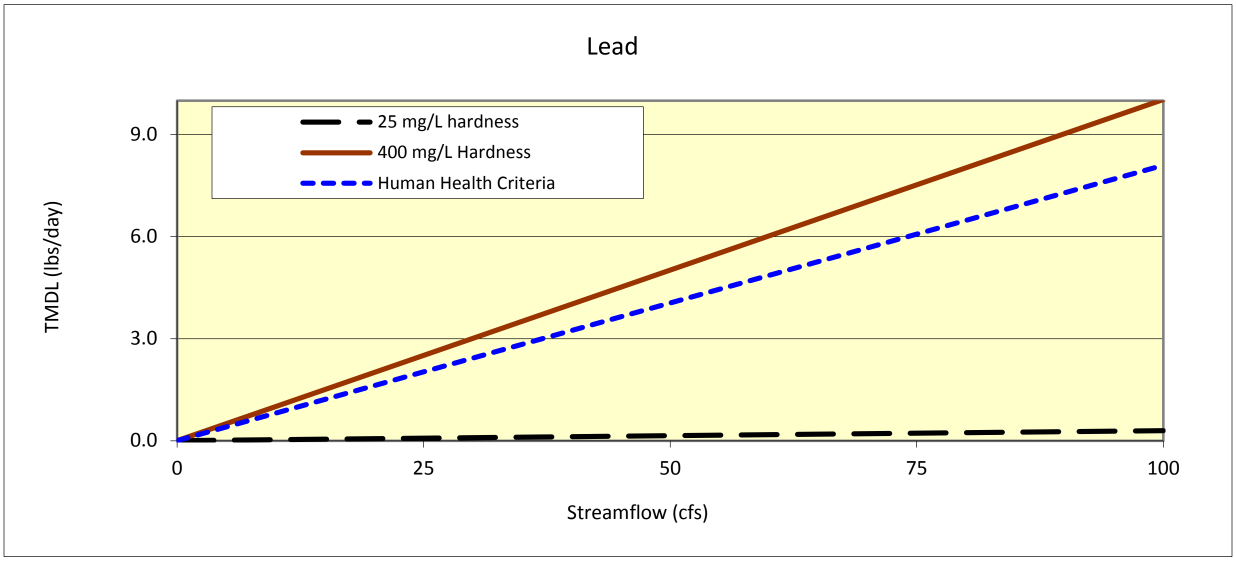

Figure 8-9. Lead TMDL as a function of flow

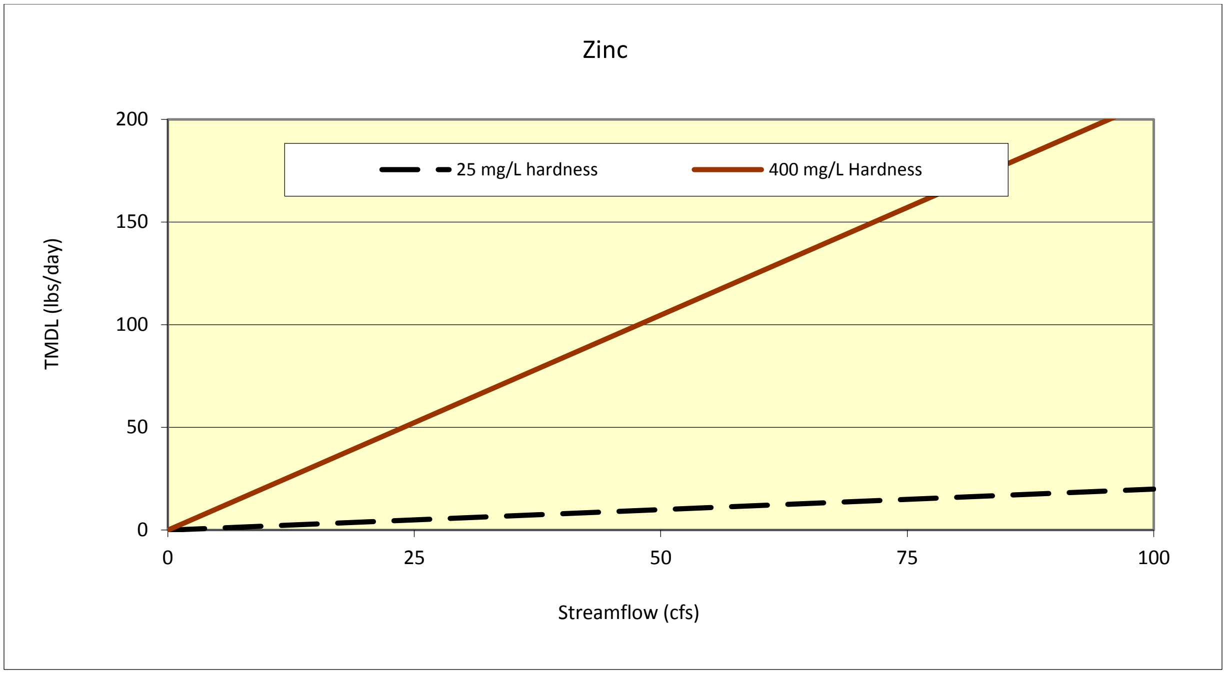

Figure 8-10. Zinc TMDL as a function of flow

Table 8-15 provides example TMDLs for each of the waterbody – impairment cause combinations in the Kootenai - Fisher project area. DEQ chose the data in **Table 8-15** by selecting the highest measured concentration for a given impairment cause for each flow regime. This accounts for seasonal variability by providing the full range of streamflow and water hardness for each waterbody –impairment cause combination (**Appendix F**). The TMDLs in **Table 8-15** are calculated according to the TMDL equation provided above.

Table 8-16 provides the calculated load reduction requirements necessary to meet each TMDL. High and low flow load reductions were calculated using the highest concentration value for a given high or low flow event and the corresponding hardness dependent target value for that given event. The required percent reduction in total load is calculated by subtracting the target value from the highest measured concentration and dividing the difference by the high concentration value. In those cases where the highest concentration was the detection limit, a zero percent reduction was assigned to that metal parameter. DEQ has chosen this approach because values below the detection limits applicable to the **Appendix F** data could not exceed a target value. This is the case for the high flow load reductions in Stanley Creek. There were also cases were the highest concentrations for a particular flow regime were identical at multiple locations (Zinc in Big Cherry Creek). In these cases the lowest hardness dependent target value was chosen to calculate the percent reduction. In the case of arsenic in Snowshoe Creek, the human health target was exceeded, and as a result, the human health value was use as the target. Those values used to calculate percent reductions are bolded in **Appendix F.**

In some cases the required percent reduction is quite high. This is based on the examples being chosen to demonstrate the highest detected metals concentrations. This may provide a somewhat misleading idea of the magnitude of the impairments, and should be considered in conjunction with the percentage of samples that exceed the lowest applicable water quality target (e.g., “exceedance rates” in **Section 8.4.3**).

In some cases the required percent reduction is zero for either high or low flow events, although in all situations there is a required percent reduction for a high and/or low flow event. The **Table 8-16** results indicate that Lake Creek impairment is a concern during high flow or runoff, although there is also low or base flow copper loading concerns. The Big Cherry Creek results suggest mainly high flow loading concerns for lead and zinc, and a combination of high and low flow concerns for cadmium. Snowshoe Creek results show a combination of high and low flow loading concerns for cadmium, lead and zinc, and a low flow loading concern for arsenic. The Stanley Creek data suggests a low flow loading concern for copper, lead and zinc.

Table 8-15. Detailed inputs for example TMDLs in the Kootenai-Fisher TMDL project area

Stream	Discharge (cfs)		Hardness (mg/L)		Metal	Target Conc. (µg/L)		TMDL (lbs/day)	
	High Flow	Low Flow	High Flow	Low Flow		High Flow	Low Flow	High Flow	Low Flow
Lake Creek MT76D002_061	285	75	40	40	Lead	0.99	0.99	1.54	0.40
					Copper	4.26	4.26	6.62	1.73
Big Cherry Creek MT76D002_050	75.0	8.3	25	33	Cadmium	0.10	0.12	0.04	0.005
					Lead	0.54	0.78	0.219	0.035
					Zinc	37.0	46.83	14.99	2.10
Snowshoe Creek MT76D002_040	40.0	0.11	NA	NA	Arsenic	10	10	2.16	0.006
			25	43	Cadmium	0.10	0.14	0.0216	0.0001
					Lead	0.54	1.09	0.117	0.0006
					Zinc	37.0	58.61	7.99	0.035
Stanley Creek *MT76D002_010*	133.7	0.32	29	25	Copper	3.24	2.85	2.34	0.005
					Lead	0.66	0.54	0.48	0.001
					Zinc	42.0	37.0	30.30	0.064

Table 8-16. High and Low Flow Load Reductions

Stream	Parameter	% Load Reduction To Meet TMDL	
		High Flow	Low Flow
Lake Creek MT76D002_061	Lead	93	0
	Copper	88	20
Big Cherry Creek MT76D002_050	Cadmium	87	86
	Lead	87	0
	Zinc	38	6
Snowshoe Creek MT76D002_040	Arsenic	0	23
	Cadmium	97	98
	Lead	98	94
	Zinc	84	91
Stanley Creek *MT76D002_010*	Copper	*0*	*68*
	Lead	*0*	*39*
	Zinc	*0*	*84*

8.6.2 Metals Allocations: Basic Approach

As discussed in **Section 4.0**, a TMDL equals the sum of all the wasteload allocations (WLAs), load allocations (LAs), and a margin of safety (MOS). WLAs are allowable pollutant loads that are assigned to permitted and non-permitted point sources. Mining-related waste sources (e.g. adit discharges, tailings accumulations, and waste rock deposits) may represent non-permitted point sources subject to WLAs. LAs are allowable pollutant loads assigned to nonpoint sources and may include the pollutant load from naturally occurring sources, as well as human-caused nonpoint loading. Where practical, LAs to human sources are provided separately from naturally occurring sources. All mining related sources are provided WLAs unless the allocation is for a mine-related source where it is know that the source loading is consistent with the definition of a nonpoint source, thus leading to the use of one or more LAs for those specific mining related sources.

In addition to metals load allocations, the TMDL must also take into account the seasonal variability of metals loads and adaptive management strategies in order to address uncertainties inherent in environmental analyses.

These elements are combined in the following equation:

TMDL = ∑WLA + ∑LA + MOS

WLA = Wasteload Allocation or the portion of the TMDL allocated to metals point sources.
LA = Load Allocation or the portion of the TMDL allocated to nonpoint metals sources and naturally occurring background
MOS = Margin of Safety or an accounting of uncertainty about the relationship between metals loads and receiving water quality.

Metals allocations in the Kootenai-Fisher TMDL project areas are provided for the following source categories:

- Mining sources (WLA_{MS})
- Naturally occurring metals sources (LA_{NAT})

DEQ provides an implicit MOS by using assumptions known to be conservative, discussed further in **Section 8.7.2**. Because an implicit MOS is applied, the MOS in the TMDL equation above is equal to zero and is not included in the equation provided below.

The resulting TMDL equation is therefore:

$$TMDL = LA_{nat} + WLA_{MS}$$

There are no MPDES-permitted discharges to surface water that require WLA development in the project area; therefore the above WLA_{MS} does not incorporate MPDES-permitted surface water discharges

Mining sources wasteload allocation (WLA_{MS})

Within the Kootenai -Fisher TMDL Planning Area, the major metals sources are related to active, inactive and abandoned mining. Although prominent abandoned/inactive mines have been investigated in each of the watersheds (**Section 8.5**), data describing individual loading contributions from historical mining is typically insufficient to guide allocations for each individual abandoned mine feature. The nature of Montana's mining legacy is such that many small non-permitted point sources (adits, seeps, tailings piles, etc.) may be scattered throughout a watershed and pass undetected. Therefore a composite wasteload allocation (WLA_{MS}) for mining sources is provided in pounds/day to any and all metals sources related to active, inactive and abandoned mines. This composite wasteload allocation approach recognizes that abandoned mine remediation is best pursued in an adaptive manner that balances remediation costs with achievable load reductions within each watershed. The WLA_{MS} is calculated for each TMDL as the difference between the TMDL and the load allocation to naturally-occurring sources (described in the following section).

Naturally occurring metals sources

Naturally occurring loading is assumed to be a result of local geology, with minimal influence from human-caused sources. Metal loading to surface water is strongly influenced by geology and streamflow rate. Bedrock composition commonly affects sediment mineralogy and surface water concentrations of many elements, including metals. Higher suspended sediment concentrations usually increase the water column solids concentration of metals and other constituents during seasonal high flows. The local bedrock geology consists of a thick series of metasedimentary rocks known as the Belt Supergroup. This geology contains metal ores, and the potential to leach metals to surface waters.

The sampling and analysis conducted by DEQ for stream assessments in the Kootenai - Fisher TMDL Project area identify eight sampling sites remote from mining and other human-caused sources. There are a few upstream monitoring sites that were not included in this data set due to their proximity to historical mining disturbances. The eight sites were located in the upper reaches of Snowshoe Creek, Libby Creek and Bear Creek. The Snowshoe Creek sites consist of SNSCA and BKK134. The Libby Creek site is K01LIBYCO3 and K01LIBYCO5. The Bear Creek sites consist of KO1BEARCO1, KO1BEARCO2, KO1BEARCO3 and KO1BEARCO4. **Table 8-17**contains measured high and low-flow values and median values for metal pollutant parameters in samples from the eight sites representing naturally occurring conditions.

In many cases, non-detects were recorded at all the monitoring sites upstream of mining sources; for purposes of load allocations to naturally-occurring metals, half the lowest detection limit is substituted for the non-detect result value (**Table 8-17**). In some cases a combination of non-detects and reported values were recorded; for the purpose of load allocation, a median of these values will be used. The median values in the shaded rows in **Table 8-17** are used to calculate the load allocations to naturally occurring sources of metals loading in the Kootenai – Fisher project area.

Table 8-17. Median High and Low Flow Metals Background Concentrations

Flow	Site ID	**As** (ug/L) TR	**Cd** (ug/L) TR	**Cu** (ug/L) TR	**Pb** (ug/L) TR	**Hg** (ug/L) T	**Zn** (ug/L) TR
High Flow	BKK134	<3	1.18	<1	2.9	---	110
	K01LIBYC03	<3	0.08	<1	0.5	<0.005	<10
	K01LIBYC05	<3	<0.08	1	<0.5	<0.005	<10
High Flow Medians		1.5	0.08	1	0.5	0.0025	10
Low Flow	K01BEARC01	<3	<0.08	<1	<0.5	<0.005	<10
	K01BEARC02	<3	<0.08	<1	<0.5	<0.005	<10
	K01BEARC03	<3	<0.08	<1	<0.5	<0.005	<10
	K01BEARC04	<3	<0.08	<1	<0.5	<0.005	<10
	SNSCA	<3	<0.08	<1	<0.5	---	<10
	BKK134	<3	<0.08	<1	1.6	---	<10
	K01LIBYC03	<3	<0.08	<1	<0.5	---	<10
Low Flow Medians		1.5	0.04	0.5	0.25	0.0025	5

The data set contains 10 sampling results for most metal parameters. The high-flow data consists of water chemistry from the upper reaches of Snowshoe Creek and Libby Creek. These samples were collected during the high flow season (May 30 and May 23, 2012 respectively). The remaining 7 low flow samples were collected during low flows in 2011 and 2012. Complete water column chemistry results for the selected background sites are included with data contained in **Table F-4** in **Appendix F**.

The sites occur in headwater reaches that are generally upstream of mining sources. Additional surface water monitoring is recommended to better define naturally occurring levels of metals loading.
When possible, background loading is accounted for separately from human-caused sources. However, the effects of past metal mining are localized within the planning area and load allocations to naturally occurring sources cannot always be expressed separately from human-caused sources. Regardless of the allocation scheme, the underlying assumption is that, naturally occurring sources alone would not exceed the target metals concentrations in the water column, or the PELs in sediment. If future monitoring disproves this assumption, metals loading analyses may need revision per the adaptive management strategy described in **Section 8.8.**

8.6.3 Allocations by Waterbody Segment

In the sections that follow, load and wasteload allocations are provided for each pollutant-waterbody combination for which a TMDL is prepared (see **Table 8-15**). Load estimations and allocations are based on a limited data set and are assumed to approximate general metals loading during high and low flow conditions. The TMDL and allocation tables in the following sections give example TMDLs for each metal pollutant parameter under both high- flow and low-flow conditions for each stream segment. The TMDLs are calculated according to the TMDL formula provided in **Section 8.6.1**.

Additionally, example loading values are calculated for reference purposes only. Due to the limited number of samples, examples are based on the highest detected pollutant concentration for each flow regime and the corresponding flow from that sampling event (**Table 8-15**).

8.6.3.1 Calculating Example TMDL, Load and Wasteload Allocations

Below is an example TMDL calculation for Zinc during high flow conditions. This calculation uses the lowest water quality target concentration (in this case 37.02 ug/L zinc, at 25 mg/L hardness) multiplied by the flow (the highest measured), multiplied by a unit conversion factor of 0.0054, to arrive at units of lbs/day. For example, the zinc TMDL in Big Cherry Creek under high flow conditions is 14.99 pounds per day (lbs/day). The flow values used to calculate TMDLs are marked by an asterisk in **Appendix F.** In the case of arsenic, there is no hardness specific standard and the human health standard was used.

High flow zinc TMDL: [37.02 µg/L X 75 cfs X 0.0054 = 14.99 lbs/day]

The load allocation to natural sources (LA_{nat}) is the same as the estimated naturally occurring load. In the case of Big Cherry Creek, the naturally occurring zinc load (LA_{nat}) is estimated as the median value of metals concentrations from streams representing background conditions, or 10 µg/L (**Table 8-18**). The high flow zinc load is calculated using the median background value (10 ug/L), multiplied by the flow (the highest measured), multiplied by a unit conversion factor of 0.0054. For a high flow of 75 cfs, natural background is 4.05 lbs/day.

High flow naturally occurring zinc load: [10.0 µg/L X 75 cfs X 0.0054 = 4.05 lbs/day]

The wasteload contributed by mining sources (WLA_{MS}) is calculated by subtracting the naturally occurring load (LA_{nat}) from the TMDL. The WLA_{MS} for every TMDL in this document may be calculated by this formula:

$$WLA_{MS} = TMDL - LA_{nat}$$

For zinc in Big Cherry Creek under high flow conditions, this is calculated as 14.99 lbs/day minus 4.05 lbs/day, resulting in a WLA_{MS} equal to 10.94 lbs/day under the example high flow conditions.

8.6.3.2 Calculating Existing Load Examples

The existing high and low flow loads are calculated using the lowest flow and highest flow values from the water quality monitoring data for each flow condition. For high flow in Big Cherry Creek this is calculated by multiplying the highest measured zinc concentration during high flows (60.0 µg/L) by the corresponding observed high flow in Big Cherry Creek of 75 cfs. The product of concentration multiplied by flow is multiplied by the conversion factor of 0.0054, giving an existing high flow zinc load of 24.3 lbs/day. For example, **Table 8-18** for Big Cherry Creek gives values of 24.3 lbs/day for existing high-flow zinc loads. The data used to calculate existing loads in all stream is shaded grey in **Appendix F.** In those cases where a concentration was reported as non-detect, half the detection limit was used.

Target exceedances are variable for each metal based on flow conditions and locations within the watershed. Therefore, example high and low flow events may or may not include target exceedances for each individual metals impairment cause. For this reason, percent reductions are not provided in the example allocation tables, and are instead provided above within **Table 8-16** of **Section 8.6.1.**

The examples provided for existing loads, TMDLs, LAs, and WLAs under both high flow and low flow conditions are based upon the following conditions:

1. The hardness values used for determining hardness-based standards and associated TMDLs, LAs, and WLAs are the values recorded with the corresponding metals sample.
2. Example TMDLs are based on the maximum and minimum flows and are the same as those presented within **Table 8-15**.
3. Existing condition load summaries are based on the maximum and minimum flows and associated concentration data.

8.6.3.3 Big Cherry Creek MT76D002_050

All example Metals TMDLs for Big Cherry Creek are expressed by the following formula:

$$TMDL_{BigCherryCreek} = LA_{nat} + WLA_{MS}$$

Table 8-18. Big Cherry Creek: Example Metals TMDLs and Allocation

Metal	Flow	TMDL	LA_{nat}	WLA_{MS}	Existing Load
Cadmium	High flow	0.0405	0.0324	0.0081	0.320
	Low flow	0.0054	0.0018	0.0036	0.038
Lead	High flow	0.219	0.203	0.016	1.701
	Low flow	0.035	0.011	0.024	0.031
Zinc	High flow	14.99	4.05	10.94	24.30
	Low flow	2.10	0.22	1.88	2.24

Units are lbs/day

Some of the existing loads in Big Cherry Creek are less than the TMDLs for this waterbody segment. This is consistent with **Table 8-16** where the low flow lead data indicate a 0% reduction, although the purpose of this table is not to provide percent reduction values. The target exceedances for specific metals parameters in Big Cherry Creek are identified in **Section 8.4.3.1.** High and low flow load reductions were calculated using the highest concentration value for a given high or low flow event and the corresponding hardness dependent target value for that given event. **Table 8-16** shows the percent reductions for metals loads measured in Big Cherry Creek based on this approach.

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for Big Cherry Creek. The source assessment for the Big Cherry Creek watershed indicates that historical mining sources contribute the most human-caused metals loading; load reductions should focus on limiting and controlling metals loading from these sources. Meeting load allocations for Big Cherry Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Sections 10.0** and **11.0**.

8.6.3.4 Stanley Creek MT76D002_010

All the example metals TMDLs for Stanley Creek are expressed by the following formula:

$$TMDL_{Stanley} = LA_{nat} + WLA_{MS}$$

Table 8-19. Stanley Creek: Example Metals TMDLs and Allocation

Metal	Flow	TMDL	LA_{nat}	WLA_{MS}	Existing Load
Copper	High flow	2.339	0.722	1.617	0.361
	Low flow	0.005	0.001	0.004	0.009
Lead	High flow	0.476	0.361	0.115	0.180
	Low flow	0.001	0.0004	0.001	0.0004
Zinc	High flow	30.3	7.218	23.082	3.609
	Low flow	0.064	0.009	0.055	0.009

Units are lbs/day

Most of the existing loads in Stanley Creek are less than the TMDLs for this waterbody segment (**Table 8-19**). This is because metals concentrations at the highest and lowest flow conditions used for the example loads were mostly below target values. That being said, the concentration data for Stanley Creek shows that there are times when the targets are exceeded and reductions are necessary. The target exceedances for specific metals parameters in Stanley Creek are identified in **Section 8.4.3.2.** High and low flow load reductions were calculated using the highest concentration value for a given high or low flow event and the corresponding hardness dependent target value for that given event. **Table 8-16** shows the percent reductions for metals loads measured in Stanley Creek based on this approach.

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for Stanley Creek. The source assessment for the Stanley Creek watershed indicates that active and historical mining sources contribute the most human-caused metals loading; load reductions should focus on limiting and controlling metals loading from these sources. Meeting load allocations for Stanley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Sections 10.0** and **11.0**.

8.6.3.5 Lake Creek MT76D002_070

All the example metals TMDLs for Lake Creek are expressed by the following formula:

$$TMDL_{lake} = LA_{nat} + WLA_{MS}$$

Table 8-20. Lake Creek: Example Metals TMDLs and Allocation

Metal	Flow	TMDL	LA_{nat}	WLA_{MS}	Existing Load
Copper	High flow	6.617	1.553	5.064	0.777
	Low flow	1.725	0.203	1.523	0.203

Table 8-20. Lake Creek: Example Metals TMDLs and Allocation

Metal	Flow	TMDL	LA_{nat}	WLA_{MS}	Existing Load
Lead	High flow	1.538	0.777	0.761	0.388
	Low flow	0.401	0.101	0.300	0.608

Most of the existing loads in Lake Creek are less than the TMDLs for this waterbody segment (low flow copper and high flow lead) (**Table 8-20**). This is because metals concentrations at the highest and lowest flow conditions for the example TMDL load were mostly below target values, and the purpose of this table is not to provide percent reduction values. That being said, the concentration data for Lake Creek shows that there are times when the targets are exceeded and reductions are necessary. The target exceedances for specific metals parameters in Lake Creek are identified in **Section 8.4.3.3.** High and low flow load reductions were calculated using the highest concentration value for a given high or low flow event and the corresponding hardness dependent target value for that given event. **Table 8-16** shows the percent reductions for metals loads measured in Lake Creek based on this approach.

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for Lake Creek. The source assessment for the Lake Creek watershed indicates that active and historical mining sources contribute the most human-caused metals loading; load reductions should focus on limiting and controlling metals loading from these sources. Meeting load allocations for Lake Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Sections 10.0** and **11.0**.

8.6.3.6 Snowshoe Creek MT76D002_040

The copper example TMDL for Snowshoe Creek is expressed by the following formula:

$$TMDL_{SnowshoeCreek} = LA_{nat} + WLA_{MS}$$

Table 8-21. Snowshoe Creek: Example Metals TMDLs and Allocation

Metal	Flow	TMDL	LA_{nat}	WLA_{MS}	Existing Load
Arsenic	High flow	2.160	0.324	1.836	0.648
	Low flow	0.006	0.001	0.005	0.001
Cadmium	High flow	0.0216	0.017	0.0046	0.632
	Low flow	0.0001	0.00002	0.0001	0.000024
Lead	High flow	0.1166	0.1080	0.0086	6.0264
	Low flow	0.0006	0.0001	0.0005	0.0010
Zinc	High flow	7.996	2.160	5.836	49.680
	Low flow	0.035	0.003	0.032	0.003

Most of the existing loads in Snowshoe Creek are less than the TMDLs for this waterbody segment (high and low flow arsenic, low flow cadmium, and low flow zinc) (**Table 8-21**). This is because metals concentrations at the highest and lowest flow conditions used for the example loads were mostly below target values, and the purpose of this table is not to provide percent reduction values. That being said, the concentration data for Snowshoe Creek show that there are times when the targets are exceeded and reductions are necessary. The target exceedances for specific metals parameters in Snowshoe Creek are identified in **Section 8.4.3.4.** High and low flow load reductions were calculated using the highest concentration value for a given high or low flow event and the corresponding hardness dependent target value for that given event. **Table 8-16** shows the percent reductions for metals loads measured in Snowshoe Creek based on this approach.

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for Snowshoe Creek. The source assessment for the Snowshoe Creek watershed indicates that historical mining sources contribute the most human-caused metals loading; load reductions should focus on limiting and controlling metals loading from these sources. Meeting load allocations for Snowshoe Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Sections 10.0** and **11.0**.

8.7 SEASONALITY AND MARGIN OF SAFETY

Streamflow, water hardness, and climate vary seasonally. All TMDL documents must consider the effects of this variability on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and designated uses. This section describes the considerations of seasonality and a margin of safety (MOS) in the Kootenai-Fisher metals TMDL development process.

8.7.1 Seasonality

Seasonality addresses the need to ensure year round designated use support. Seasonality is considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. For metals TMDLs, seasonality is important because metals loading pathways and water hardness change from high to low flow conditions. During high flows, loading associated with overland flow and erosion of metals-contaminated soils and mine wastes tend to be the major cause of elevated metals concentrations. During low flow, groundwater transport and/or adit discharges tend to be the major source of elevated metals concentrations. Hardness tends to be lower during higher flow conditions, which leads to more stringent water quality standards for hardness-dependent metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals concentrations and loading conditions are evaluated for both high flow and low flow conditions. DEQ’s assessment method requires a combination of both high and low flow sampling for target evaluation since abandoned mines and other metals sources can lead to elevated metals loading during high and/or low flow conditions.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals concentration targets apply year round, with monitoring criteria for target attainment developed to address seasonal water quality extremes associated with loading and hardness variations.
- A sediment chemistry target is applied as a supplemental indicator to help capture impacts from episodic metals loading events that could be attributed to high flow seasonal runoff conditions.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions. The TMDL equation incorporates all potential flow conditions that may occur during any season.

8.7.2 Margin of Safety

The margin of safety is to ensure that TMDLs and allocations are sufficient to sustain conditions that will support designated uses. All metals TMDLs incorporate an implicit MOS in several ways, using conservative assumptions throughout the TMDL development process, as summarized below:

- DEQ's assessment process includes a mix of high and low flow sampling since abandoned mines and other metals sources can lead to elevated metals loading during high and/or low flow stream conditions. The seasonality considerations help identify the low range of hardness values and thus the lower range of applicable TMDL values shown within the TMDL curves and captured within the example TMDLs.
- Target attainment, refinement of load allocations, and, in some cases, impairment validations and TMDL-development decisions are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.
- Although a 10% exceedance rate is allowed for chronic and acute based aquatic life targets, the TMDLs are set so the lowest applicable target is satisfied 100% of the time. This focuses remediation and restoration efforts toward 100% compliance with all targets, thereby providing a margin of safety for the majority of conditions where the most protective (lowest) target value is linked to the numeric aquatic life standard. As part of this, the existing water quality conditions and needed load reductions are based on the highest measured value for a given flow conditions in order to consistently achieve the TMDL.
- The monitoring results used to estimate existing water quality conditions are instantaneous measurement used to estimate a daily load, whereas chronic aquatic life standards are based on average conditions over a 96-hour period. This provides a margin of safety since a four-day loading limit could potentially allow higher daily loads in practice.
- The lowest or most stringent numeric water quality standard was used for TMDL target and impairment determination for all waterbody – pollutant combinations. This ensures protection of all designated beneficial uses.
- Sediment metals concentration criteria were used as a supplemental indicator target. This helps ensure that episodic loading events were not missed as part of the sampling and assessment activity.
- The TMDLs are based on numeric water quality standards developed at the national level via EPA and incorporate a margin of safety necessary for the protection of human health and aquatic life.

8.8 UNCERTAINTY AND ADAPTIVE MANAGEMENT

The environmental studies required for TMDL development include inherent uncertainties: accuracy of field and laboratory data, for example. Data concerns are managed by DEQ's data quality objective (DQO) process. The use of DQOs ensures that the data is of known (and acceptable) quality. The DQO process develops criteria for data performance and acceptance that clarify study intent, define the appropriate type of data, and establish minimum standards for the quality and quantity of data.

The accuracy of source assessments and loading analyses is another source of uncertainty. An adaptive management approach that revisits, confirms, or updates loading assumptions is vital to maintaining stakeholder confidence and participation in water quality improvement. Adaptive management uses updated monitoring results to refine loading analysis, to further customize monitoring strategies and to develop a better understanding of impairment conditions and the processes that affect impairment. Adaptive management recognizes the dynamic nature of pollutant loading and water quality response to remediation.

Adaptive management also allows for continual feedback on the progress of restoration and the status of beneficial uses. Additional monitoring and resulting refinements to loading can improve t achieving and measuring success. A remediation and monitoring framework is closely linked to the adaptive management process, and is addressed in **Section 11.0**.

The metals TMDLs developed for the Kootenai –Fisher TMDL Project Area are based on future attainment of water quality standards. In order to achieve this, all significant sources of metals loading must be addressed via all reasonable land, soil, and water conservation practices. DEQ recognizes however, that in spite of all reasonable efforts, this may not be possible due to natural background conditions and/or the potential presence of unalterable human-caused sources that cannot be fully addressed via reasonable remediation approaches. For this reason, an adaptive management approach is adopted for all metals targets described within this document. Under this adaptive management approach, all metals impairments that required TMDLs will ultimately fall into one of the categories identified below:

- Restoration achieves the metal pollutant targets and all beneficial uses are supported.
- Targets are not attained because of insufficient controls; therefore, impairment remains and additional remedies are needed.
- Targets are not attained after all reasonable BMPs and applicable abandoned mine remediation activities are applied. Under these circumstances, site-specific standards may be necessary.
- Targets are unattainable due to naturally-occurring metals sources. Under this scenario, site-specific water quality standards and/or the reclassification of the waterbody may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target would reflect the background condition.

The Abandoned Mines Section of DEQ’s Remediation Division will lead abandoned mine restoration projects funded by provisions of the Surface Mine Reclamation and Control Act of 1977. DEQ’s Federal Superfund Bureau (also in the Remediation Division) will provide technical and management assistance to EPA for remedial investigations and cleanup actions at national priority listed mine sites in federal-lead status.

Monitoring and restoration conducted by other parties (e.g. USFS, the Montana Department of Natural Resources and Conservation’s Trust Lands Management Division, Montana bureau of Mines and Geology) should be incorporated into the target attainment and review process as well. Cooperation among agency land managers in the adaptive management process for metals TMDLs will help identify further cleanup and load reduction needs, evaluate monitoring results, and identify water quality trends.

9.0 NON-POLLUTANT IMPAIRMENTS

Water quality issues are not limited simply to those streams where TMDLs are developed. In some cases, streams have not yet been reviewed through the water quality assessment process and do not appear on Montana's list of impaired waters, even though they may not be fully supporting all of their beneficial uses. In other cases, a stream may listed as impaired, but does not require TMDL development because it is determined not to be impaired for a pollutant, but for a non-pollutant (TMDLs are only required for pollutant causes of impairment). Non-pollutant causes of impairment such as "alteration in streamside or littoral vegetative covers" are often associated with sediment, nutrient, or temperature issues, but may be having a deleterious effect on beneficial uses without a clearly defined quantitative measurement or direct linkage to a pollutant.

Non-pollutant impairments have been recognized by DEQ as limiting their ability to fully support all beneficial uses and are important to consider when improving water quality conditions in individual streams, and the project area as a whole. **Table 9-1** presents the non-pollutant impairments in the Kootenai-Fisher project area and indicates those streams that either do not have any associated pollutant listings or do not have a TMDL in this document. Non-pollutant causes of impairment were not investigated for streams that do not have a TMDL in this document. They are being summarized in this section to increase awareness of the non-pollutant impairment definitions and typical sources. Additionally, the restoration strategies discussed in **Section 10.0** inherently address some or all of the non-pollutant impairments, and many of the BMPs necessary to meet TMDLs will also address non-pollutant sources of impairment. As mentioned above, these impairment causes should be considered during planning of watershed scale restoration efforts.

Table 9-1. Waterbody segments with non-pollutant impairments in the 2012 Water Quality Integrated Report

Waterbody & Location Description	Waterbody ID	Impairment Cause
BIG CHERRY CREEK, Snowshoe Creek to mouth (Libby Creek)	MT76D002_050	Alteration in streamside or littoral vegetative covers; Physical substrate habitat alterations
[1]**CRIPPLE HORSE CREEK**, Headwaters to mouth (Lake Koocanusa)	MT76D002_100	Low flow alterations; Physical substrate habitat alterations
[1]**DRY CREEK,** 1 mile upstream from State Highway 56 to mouth (Lake Creek)	MT76D002_020	Other flow regime alterations; Physical substrate habitat alterations
[1]**FISHER RIVER**, Silver Butte / Pleasant Valley junction to mouth (Kootenai River)	MT76C001_010	High Flow Regime
[1]**KEELER CREEK**, Headwaters to Lake Creek	MT76D002_030	Low flow alterations; Physical substrate habitat alterations
[2]**KOOTENAI RIVER**, Libby Dam to Yaak River	MT76D001_010	Other flow regime alterations
[2]**KOOTENAI RIVER**, Confluence with Yaak River to Idaho border	MT76A001_010	Other flow regime alterations
[2]**LAKE KOOCANUSA**	MT76D003_010	Other flow regime alterations
LIBBY CREEK, 1 mile above Howard Creek to Highway 2 bridge	MT76D002_061	Alteration in streamside or littoral vegetative covers; Physical substrate habitat alterations
LIBBY CREEK, Highway 2 bridge to mouth (Kootenai River)	MT76D002_062	Physical substrate habitat alterations

Table 9-1. Waterbody segments with non-pollutant impairments in the 2012 Water Quality Integrated Report

Waterbody & Location Description	Waterbody ID	Impairment Cause
RAVEN CREEK, Headwaters to mouth (Pleasant Valley Fisher River)	MT76C001_030	Alteration in streamside or littoral vegetative covers
[3]**QUARTZ CREEK**, Headwaters to confluence with Kootenai River	MT76D002_090	Physical substrate habitat alterations
SNOWSHOE CREEK, Cabinet Wilderness boundary to mouth (Big Cherry Creek)	MT76D002_040	Alteration in streamside or littoral vegetative covers
WOLF CREEK, Headwaters to mouth (Fisher River)	MT76C001_020	Alteration in streamside or littoral vegetative covers

[1] Streams listed for non-pollutant cause(s) only, with no pollutant listings or no TMDL in this document.
[2] Waterbody that is outside the scope of this document but is included for informational purposes.
[3] This cause is being removed for the 2014 303(d) List (along with sedimentation).

9.1 NON-POLLUTANT IMPAIRMENT CAUSES DESCRIPTIONS

Non-pollutants are often used as a probable cause of impairment when available data at the time of a water quality assessment does not provide a direct, quantifiable linkage to a specific pollutant. In some cases, the pollutant and non-pollutant categories are linked and appear together in the list of impairment causes for a waterbody; however a non-pollutant impairment cause may appear independently of a pollutant cause. The following discussion provides some rationale for the application of the identified non-pollutant causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation or remediation.

Alteration in Streamside or Littoral Vegetation Covers

Alteration in streamside or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the streamside vegetation, destabilized banks from loss of vegetative root mass could lead to overwidened stream channel conditions, elevated sediment and/or nutrient loads, and the resultant lack of canopy cover can lead to increased water temperatures.

Physical Substrate Habitat Alterations

Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from human-influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

High Flow Regime or Other Flow Alterations

Flow alteration refers to a change in the flow characteristics of a waterbody relative to natural conditions. An impairment listing caused by high flow regime or other flow alterations could be associated with changes in runoff and streamflow due to activities such as urban development, road construction, or timber harvest. Changes in runoff are commonly linked to elevated peak flows, which can also cause excess sedimentation by increasing streambank erosion and channel scour. Road crossings, particularly where culverts are undersized or inadequately maintained, can also alter flows by causing water to back up upstream of the culvert. An impairment listing for other flow alterations can also be associated with human sources that cause a reduction in surface flow because of excessive sedimentation or channel modifications. Lastly, an impairment listing for other flow alterations may be associated with an impoundment or dam. Flow modifications caused by a dam can affect fish spawning, dissolved gas concentrations, water temperatures, channel form, and suspended and bottom sediment concentrations. Note: under Montana's Administrative Rules (ARM 17.30.602(17)), dams that have been in existence since at least July 1, 1971, and are being operated reasonably, are considered natural.

Low Flow Alterations

Streams are typically listed as impaired for low flow alterations when irrigation withdrawal management leads to base flows that are too low to support the beneficial uses designated for that system. This could result in dry channels or extreme low flow conditions unsupportive of fish and aquatic life. It could also result in lower flow conditions which absorb thermal radiation more readily and increase stream temperatures, which in turn creates dissolved oxygen conditions too low to support some species of fish.

It should be noted that while Montana law states that TMDLs cannot impact Montana water rights and thereby affect the allowable flows at various times of the year, the identification of low flow alterations as a probable source of impairment does not violate any state or federal regulations or guidance related to stream assessment and beneficial use determination. Subsequent to the identification of this as a probable cause of impairment, it is up to local users, agencies, and entities to improve flows through water and land management.

9.2 MONITORING AND BMPS FOR NON-POLLUTANT AFFECTED STREAMS

Habitat alteration impairments (i.e., alteration in streamside or littoral vegetative covers and physical substrate habitat alterations) can be linked to sediment TMDL development for lower Libby, Raven, and Wolf creeks. It is likely that meeting the sediment TMDL targets will also equate to addressing the habitat impairment conditions in each of these streams. For streams with habitat alteration impairments that do not have a sediment TMDL, meeting the sediment targets applied to streams of similar size will likely equate to addressing the habitat impairment condition for each stream.

Streams listed for non-pollutant impairments should not be overlooked when developing watershed management plans. Attempts should be made to collect sediment, nutrient, and temperature information where data is minimal and the linkage between probable cause, non-pollutant listing, and effects to the beneficial uses is not well defined. The monitoring and restoration strategies that follow in **Sections 10.0** and **11.0** are presented to address both pollutant and non-pollutant issues for streams in the Kootenai-Fisher project area with TMDLs in this document, and they are equally applicable to streams listed for the above non-pollutant impairment causes.

10.0 WATER QUALITY IMPROVEMENT PLAN

10.1 PURPOSE OF IMPROVEMENT STRATEGY

This section describes an overall strategy and specific on-the-ground measures designed to restore water quality beneficial uses and attain water quality standards in Kootenai-Fisher TMDL project area streams. The strategy includes general measures for reducing loading from each identified significant pollutant source.

This section should assist stakeholders in developing a watershed restoration plan (WRP) that will provide more detailed information about restoration goals within the watershed. The WRP may also encompass broader goals than the water quality improvement strategy outlined in this document. The intent of the WRP is to serve as a locally organized “road map” for watershed activities, prioritizing types of projects, sequences of projects, and funding sources towards achieving local watershed goals. Within the WRP, local stakeholders identify and prioritize streams, tasks, resources, and schedules for applying best management practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, this strategy could be adapted and revised by stakeholders based on new information and ongoing improvements.

10.2 ROLE OF DEQ, OTHER AGENCIES, AND STAKEHOLDERS

The Montana Department of Environmental Quality (DEQ) does not implement TMDL pollutant-reduction projects for nonpoint source activities, but may provide technical and financial assistance for stakeholders interested in improving their water quality. Successful implementation of TMDL pollutant-reduction projects requires collaboration among private landowners, land management agencies, and other stakeholders. DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help support water quality improvement and pollution prevention projects, and help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers work collaboratively with local and state agencies to achieve water quality restoration goals and to meet TMDL targets and load reductions. Specific stakeholders and agencies that will likely be vital to restoration efforts for streams discussed in this document include:

- Lincoln Conservation District
- Kootenai River Network (KRN)
- U.S. Forest Service (USFS)
- Natural Resources and Conservation Service (NRCS)
- U.S. Fish & Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (EPA)
- Montana Department of Natural Resources and Conservation (DNRC)
- Montana Fish, Wildlife and Parks (FWP)
- Montana Department of Environmental Quality (DEQ)
- Kootenai Tribe of Idaho
- Plum Creek Timber Company
- Revett Minerals, Inc.
- Mines Management Inc.

Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include:

- Flathead Conservation District
- Montana Trout Unlimited
- U.S. Army Corp of Engineers
- Montana Department of Transportation
- Montana Bureau of Mines and Geology
- Montana Water Center (at Montana State University)
- University of Montana Watershed Health Clinic
- Montana Aquatic Resources Services
- Montana State University Extension Water Quality Program

10.3 WATER QUALITY RESTORATION OBJECTIVES

The water quality restoration objective for the Kootenai-Fisher Project Area is to reduce pollutant loads as identified throughout this document in order to meet the water quality standards and TMDL targets for full recovery of beneficial uses for all impaired streams. Meeting the TMDLs provided in this document will achieve this objective for all identified pollutant-impaired streams. Based on the assessment provided in this document, the TMDLs can be achieved through proper implementation of appropriate BMPs.

A WRP can provide a framework strategy for water quality restoration and monitoring in the Kootenai-Fisher TMDL Project Area, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document, as well as other water quality issues of interest to local communities and stakeholders. WRPs identify considerations that should be addressed during TMDL implementation and should assist stakeholders in developing a more detailed adaptive plan in the future. A locally developed WRP will likely provide more detailed information about restoration goals and spatial considerations but may also encompass more broad goals than this framework includes. A WRP would serve as a locally organized “road map” for watershed activities, sequences of projects, prioritizing of projects, and funding sources for achieving local watershed goals, including water quality improvements. The WRP is intended to be a living document that can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities.

The EPA requires nine minimum elements for a WRP, summarized here:

1. Identification of the causes and sources of pollutants
2. Estimated load reductions expected based on implemented management measures
3. Description of needed nonpoint source management measures
4. Estimate of the amounts of technical and financial assistance needed
5. An information/education component
6. Schedule for implementing the nonpoint source management measures
7. Description of interim, measurable milestones
8. Set of criteria that can be used to determine whether loading reductions are being achieved over time
9. A monitoring component to evaluate effectiveness of the implementation efforts over time

This document provides, or can serve as an outline, for many of the required elements. Water quality goals for sediment, nutrients, temperature, and metals pollutants are detailed in **Sections 5, 6, 7, and 8**, respectively. These goals include water quality and habitat targets as measures for long-term effectiveness monitoring. These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses of waterbodies in the Kootenai-Fisher TMDL Project Area. It is presumed that meeting all water quality and habitat targets will achieve the water quality goals for each impaired waterbody. **Section 11** identifies a general monitoring strategy and recommendations to track post-implementation water quality conditions and measure restoration successes.

In 2010, the USFWS approved a Native Fish Habitat Conservation Plan (NHCP) developed by Plum Creek Timber Company, Inc. (Plum Creek) for approximately 900,000 acres of company land. Habitat Conservation Plans are long-term management plans developed under authorization of the Endangered Species Act and directed toward conservation of key species such as the Bull Trout. Plum Creek is the largest private landowner within the Kootenai-Fisher TMDL Project Area. The NHCP contains mitigation measures to protect coldwater fisheries and includes detailed management prescriptions for grazing, timber harvest, and road construction and maintenance activities. The NHCP can serve as a model for WRPs developed in the Kootenai-Fisher TMDL Project Area.

10.4 OVERVIEW OF MANAGEMENT RECOMMENDATIONS

TMDLs were completed for four waterbody segments for sediment, one waterbody segment for temperature, three waterbody segments for nutrients, and four waterbody segments for metals. Other streams in the project area may be in need of restoration or pollutant reduction, but insufficient information about them precludes TMDL development at this time. The following sub-sections describe some generalized recommendations for implementing projects to achieve the TMDLs. Details specific to each stream, and therefore which of the following strategies may be most appropriate, are found within **Section 5.0, 6.0, 7.0** and **8.0**.

In general, restoration activities can be separated into two categories: active and passive. Passive restoration allows natural succession to occur within an ecosystem by removing a source of disturbance. Fencing off riparian areas from cattle grazing is a good example of passive restoration. Active restoration, on the other hand involves accelerating natural processes or changing the trajectory of succession. For example, historic placer mining often resulted in the straightening of stream channels and piling of processed rock on the streambank. These impacts would take so long to recover passively that active restoration methods involving removal of waste rock and rerouting of the stream channel would likely be necessary to improve stream and water quality conditions. In general, passive restoration is preferable for sediment, temperature, and nutrient problems because it is generally more cost effective, less labor intensive, and will not result in short term increase of pollutant loads as active restoration activities may. However, in some cases active restoration is the only feasible mechanism for achieving desired goals; these activities must be assessed on a case by case basis (Nature Education, 2013).

10.4.1 Sediment Restoration Approach

The goal of the sediment restoration strategy is to limit the availability, transport, and delivery of excess sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. Monitoring data used to develop targets and determine impairments are described in **Section 5.0** and in **Appendices C and D** and **Attachment A**. Sediment restoration activities on impaired stream segments will help reduce the amount of fine sediment, reduce width/depth ratio, increase residual pool depth, increase pool frequency, increase the amount of large woody debris (LWD), increase riparian understory shrub cover, reduce impacts of human-caused sediment sources, and restore appropriate macroinvertebrate assemblages. These are indicators of successful restoration activities targeted toward sediment reduction and need to be considered together and within the context of stream potential in comparison to appropriate reference sites. For example, LWD and pool frequency tend to decline as stream size increases; therefore, indicators for these parameters will vary. General targets for these indicators are summarized in **Table 5-2**.

Streamside riparian and wetland vegetation restoration and long term management are crucial to achieving the sediment TMDLs. Native streamside riparian and wetland vegetation provides root mass which hold streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian and wetland vegetation filters pollutants from upland runoff. Therefore, improving riparian and wetland vegetation will decrease bank erosion by improving streambank stability and will also reduce pollutant delivery from upland sources. Suspended sediment is also deposited more effectively in healthy riparian zones and wetland areas during flooding because water velocities slow in these areas enough for excess sediment to settle out. Restoration recommendations involve the promotion of riparian and wetland recovery through improved grazing and land management (including the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of off-site watering areas), application of timber harvest best management practices, restoration of streams affected by mining activity, floodplain and streambank stabilization, revegetation efforts, and instream channel and habitat restoration where necessary. Appropriate BMPs will differ by location and are recommended to be included and prioritized as part of a comprehensive watershed scale plan (e.g., WRP).

Unpaved roads are a small source of sediment at the watershed scale; however, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams primarily include measures that divert water to ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. In addition, routine maintenance of unpaved roads (particularly near stream crossings) and proper sizing and maintenance of culverts, are crucial components to limiting sediment production from roads.

Mining was not specifically discussed in the source assessment, but waste materials can be a component of upland and in-channel sediment loading. The goal of the sediment restoration strategy is to limit the input of sediment to stream channels from abandoned mine sites and other mining-related sources. Goals and objectives for future restoration work include the following:

- Prevent waste rock and tailings materials/sediments from migrating into adjacent surface waters, to the extent practicable.
- Reduce or eliminate concentrated runoff and discharges that transport sediment to adjacent surface waters, to the extent practicable.
- Identify, prioritize, and select response and restoration actions of areas affected by historical mining, based on a comprehensive source assessment and risk analysis.

10.4.2 Temperature Restoration Approach

The goal of the temperature restoration approach is to reduce water temperatures where possible to be consistent with naturally occurring conditions. The most significant mechanism for reducing water temperature in Wolf Creek is increasing riparian shade. Other factors that will help are: using water conservation measures to maximize water left in the stream, improving overwidened portions of the stream, and maintaining conditions where Wolf Creek is currently meeting the target.

Increases in shade can be accomplished through the restoration and protection of shade-providing vegetation within the riparian corridor. This type of vegetation can also have the added benefit of improving streambank stabilization to reduce bank erosion, slowing lateral river migration, and providing a buffer to prevent pollutants from upland sources from entering the stream. In some cases, this can be achieved by limiting the frequency and duration of livestock access to the riparian corridor, or through other grazing related BMPs such as installing water gaps or off-site watering. Other areas may require planting, active bank restoration, and protection from browse to establish vegetation.

Given the limited amount of consumptive water use in the Wolf Creek watershed, it is unknown to what extent instream flow could be increased, if at all. If increases in instream summer flows are possible, they can be achieved through a thorough investigation of water use practices and water conveyance infrastructure, and a willingness and ability of local water users to keep more water in the stream. This TMDL document cannot, nor is it intended to, prescribe limitations on individual water rights owners and users. Local water users should work collectively and with local, state, and federal resource management professionals to review water use options and available assistance programs.

Recovery of stream channel morphology in most cases will occur slowly over time and follow the improvement of riparian condition, stabilization of streambanks, and reduction in overall sediment load. For smaller streams, there may be discrete locations or portions of reaches that demand a more rapid intervention through active physical restoration, but size, scale, and cost of restoration in most cases are limiting factors to applying this type of remedy.

The above approaches give only the broadest description of activities to help reduce water temperatures. The temperature assessment described in **Section 7.0** looked at possible scenarios based on limited information at the watershed scale. Those scenarios showed that improvements in stream temperatures can primarily be made by improvements to riparian shade. It is strongly encouraged that resource managers and land owners continue to work to identify all potential areas of improvement and develop projects and practices to reduce stream temperatures in Wolf Creek.

10.4.3 Nutrients Restoration Approach

The goal of the nutrient restoration strategy is to reduce nutrient input to stream channels by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, and limiting the transport of nutrients from rangeland, cropland and mined areas (including impoundments and other storage facilities).

Cropland filter strip extension, vegetative restoration, and long-term filter area maintenance are vital BMPs for agricultural areas. Grazing systems with the explicit goal of increased vegetative post-grazing ground cover are needed to address the same nutrient loading from rangelands. Grazing prescriptions that enhance the filtering capacity of riparian filter areas offer a second tier of controls on the sediment content of upland runoff. Grazing and pasture management adjustments should consider:

- The timing, frequency, and duration of near-stream grazing
- The spacing and exposure duration of on-stream watering locations
- Provision of off-stream watering areas to minimize near-stream damage and allow impoundment operations that minimize salt accumulations
- Active reseeding and rest rotation of locally damaged vegetation stands
- Improved management of irrigation systems

- Incorporation of streamside vegetation buffer to irrigated croplands and animal feeding areas

In general, these are sustainable grazing and cropping practices that can reduce nutrient inputs while meeting production goals. The appropriate combination of BMPs will differ according to landowner preferences and equipment but are recommended as components of a comprehensive plan for farm and ranch operators. Sound planning combined with effective conservation BMPs should be sought whenever possible. Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in Montana. The local USDA Service Center and county conservation district offices are geared to offer both planning and implementation assistance.

In addition to the agricultural-related BMPs, a reduction of sediment delivery from roads and eroding streambanks is another component of the nutrient reduction restoration plan, particularly where excess phosphorus is a problem. Additional sediment-related BMPs are presented in **Section 10.5.**

Source assessment work during this project indicated mining activities are a source of nitrate loading to Lake and Stanley creeks. Since nitrate is a byproduct of blasting explosives used during mining, the explosives are the most likely source of nitrogen associated with mining. It could be transferred to surface water via groundwater from the mine void migrating through fractured bedrock, from unlined waste impoundments, discharging mine adits, and mine wastes on-site or in-channel. The goal of the nutrient restoration strategy is to limit the input of nutrients to stream channels from active and abandoned mine sites. The source assessment conducted to support TMDL development (**Section 6.5**) can help provide a starting point for where most loading is occurring, but for most of the mining-related sources, additional analysis and identification will likely be required to identify site-specific delivery pathways and to develop mitigation plans.

10.4.4 Metals Restoration Approach

Metal mining is the principal human-caused source of excess metals loading in the project area. To date, federal and state government agencies have funded and completed reclamation projects associated with past mining. Statutory mechanisms and corresponding government agency programs will continue to have the leading role for future restoration. Restoration of metals sources is typically conducted under state and federal cleanup programs. Rather than a detailed discussion of specific BMPs, general restoration programs and funding sources applicable to mining sources of metals loading are provided in **Section 10.5.7** and **Appendix H.** Past efforts have produced abandoned mine site inventories with enough descriptive detail to prioritize the properties contributing the largest metals loads. Additional monitoring needed to further describe impairment conditions and loading sources is addressed in **Section 11.3.1**

10.4.5 Non-Pollutant Restoration Approach

Although TMDL development is not required for non-pollutant listings, they are frequently linked to pollutants, and addressing non-pollutant causes, such as flow and habitat alterations, is an important component of TMDL implementation. Non-pollutant listings within the Kootenai-Fisher TMDL Project Area are described in **Section 9.0**. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Therefore, if restoration goals within the Kootenai-Fisher TMDL Project Area are not also addressing non-pollutant impairments, additional non-pollutant related BMP implementation should be considered.

10.5 RESTORATION APPROACHES BY SOURCE

General management recommendations are outlined below for the major sources of human caused pollutant loads in the Kootenai-Fisher TMDL Project Area: agricultural sources, residential development, forestry and timber harvest, riparian and wetland vegetation removal, roads, and mining. Applying BMPs is the core of the nonpoint source pollutant reduction strategy, but BMPs are only part of a watershed restoration strategy. For each major source, BMPs will be most effective as part of a comprehensive management strategy. The WRP developed by local watershed groups should contain more detailed information on restoration goals and specific management recommendations that may be required to address key pollutant sources. BMPs are usually identified as a first effort and further monitoring and evaluation of activities and outcomes, as part of an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality standards. Monitoring is an important part of the restoration process, and monitoring recommendations are outlined in **Section 11.0**.

10.5.1 Agriculture Sources

Reduction of pollutants from upland agricultural sources can be accomplished by limiting the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil and runoff before it enters a waterbody. The main BMP recommendations for the Kootenai-Fisher TMDL Project Area are riparian buffers, wetland restoration, and vegetated filter strips, where appropriate. These methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. Filter strips and buffers are even more effective for reducing upland agricultural related sediment when used in conjunction with BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, and strip-cropping (although currently there is very little cropping activity that occurs in the Kootenai-Fisher TMDL Project Area). Additional BMP information, design standards and effectiveness, and details on the suggested BMPs can be obtained from your local USDA Agricultural Service Center and in Montana’s Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b).

An additional benefit of reducing sediment input to the stream is a decrease in sediment-bound nutrients. Reductions in sediment loads may help address some nutrient related problems. Nutrient management considers the amount, source, placement, form, and timing of plant nutrients and soil amendments. Conservation plans should include the following information (NRCS Conservation Practice Standard 590 and 590-1, Nutrient Management) (United States Department of Agriculture, Natural Resources Conservation Service, 2005):

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- A detailed nutrient budget
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of environmentally sensitive areas, including streams, wetlands, springs, or other locations that deliver surface runoff to groundwater or surface water
- Guidelines for operation and maintenance

10.5.1.1 Grazing

Grazing has the potential to increase sediment and nutrient loads, as well as stream temperatures (by altering channel width and riparian vegetation), but these effects can be mitigated with appropriate management. Development of riparian grazing management plans should be a goal for any landowner who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county, federal, and local conservation groups to establish and implement appropriate grazing management plans. Note that riparian grazing management does not necessarily eliminate all grazing in riparian corridors. In some areas however, a more limited management strategy may be necessary for a period of time in order to accelerate reestablishment of a riparian community with the most desirable species composition and structure.

Every livestock grazing operation should have a grazing management plan. The NRCS Prescribed Grazing Conservation Practice Standard (Code 528) recommends the plan include the following elements (Natural Resource Conservation Service, 2010):

- A map of the operation showing fields, riparian and wetland areas, winter feeding areas, water sources, animal shelters, etc.
- The number and type of livestock
- Realistic estimates of forage needs and forage availability
- The size and productivity of each grazing unit (pasture/field/allotment)
- The duration and time of grazing
- Practices that will prevent overgrazing and allow for appropriate regrowth
- Practices that will protect riparian and wetland areas and associated water quality
- Procedures for monitoring forage use on an ongoing basis
- Development plan for off-site watering areas

Reducing grazing pressure in riparian and wetland areas and improving forage stand health are the two keys to preventing nonpoint source pollution from grazing. Grazing operations should use some or all of the following practices:

- Minimizing or preventing livestock grazing in riparian and wetland areas
- Providing off-stream watering facilities or using low-impact water gaps to prevent ‘loafing’ in wet areas
- Managing riparian pastures separately from upland pastures
- Installing salt licks, feeding stations, and shelter fences in areas that prevent ‘loafing’ in riparian areas and help distribute animals
- Replanting trodden down banks and riparian and wetland areas with native vegetation (this should always be coupled with a reduction in grazing pressure)
- Rotational grazing or intensive pasture management that takes season, frequency, and duration into consideration

The following resources provide guidance to help prevent pollution and maximize productivity from grazing operations:

- Plum Creek Timber Company’s Native Fish Habitat Conservation Plan (http://www.plumcreek.com/Environment/nbspSustainableForestrySFI/nbspSFIImplementation/HabitatConservationPlans/tabid/153/Default.aspx)
- USDA, Natural Resources Conservation Service
  Offices serving Lincoln County are located in Eureka and Kalispell (find your local USDA

Agricultural Service Center listed in your phone directory or on the Internet at www.nrcs.usda.gov)
- Montana State University Extension Service (www.extn.msu.montana.edu)
- DEQ Watershed Protection Section (Nonpoint Source Program): Nonpoint Source Management Plan (http://deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx)

The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian and wetland vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the Kootenai-Fisher TMDL Project Area are limiting livestock access to streams and stabilizing the stream at access points, providing off-site watering sources when and where appropriate, planting native stabilizing vegetation along streambanks, and establishing and maintaining riparian buffers. Although bank revegetation is a preferred BMP, in some instances bank stabilization may be necessary prior to planting vegetation.

10.5.1.2 Flow and Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow can have a profound effect on the ability of a stream to flush sediment and attenuate other pollutants, especially nutrients, metals and heat. Flow reduction may increase water temperature, allow sediment to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced (Andrews and Nankervis, 1995; Schmidt and Potyondy, 2004). Restoration targets and implementation strategies recognize the need for specific flow regimes, and may suggest flow-related improvements as a means to achieve full support of water quality beneficial uses. However, local coordination and planning are especially important for flow management because state law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana’s water quality law (MCA 75-5-705).

Irrigation management is a critical component of attaining both coldwater fishery conservation and TMDL goals. Understanding irrigation water, groundwater, and surface water interactions is an important part of understanding how irrigation practices will affect streamflow during specific seasons.

Some irrigation practices in western Montana are based on flood irrigation methods. Occasionally head gates and ditches leak, which can decrease the amount of water in diversion flows. The following recommended activities could potentially result in notable water savings:
- Install upgraded head gates for more exact control of diversion flow and to minimize leakage when not in operation
- Develop more efficient means to supply water to livestock
- Determine necessary diversion flows and timeframes that would reduce over watering and improve forage quality and production
- Where appropriate, redesign or reconfigure irrigation systems
- Upgrade ditches (including possible lining, if appropriate) to increase ditch conveyance efficiency

Some water from spring and early summer flood irrigation likely returns as cool groundwater to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer groundwater returns to the river should be identified as areas where year round irrigation efficiencies could be more beneficial than seasonal management practices. Winter baseflow should also be considered during these investigations.

10.5.1.3 Cropland

The primary strategy of the recommended cropland BMPs is to reduce sediment inputs. The major factors involved in decreasing sediment loads are reducing the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil before it enters waterbodies. The main BMP recommendations for the Kootenai-Fisher TMDL Project Area are vegetated filter strips and riparian buffers. Both of these methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept sediment. Effectiveness is typically about 70% for the filter strips and 50% for the buffers (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b). Filter strips and buffers are most effective when used in conjunction with agricultural BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, strip cropping, and precision farming. Filter strips along streams should be composed of natural vegetative communities. Additional BMPs and details on the suggested BMPs can be obtained from NRCS and in Appendix A of Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b).

10.5.2 Forestry and Timber Harvest

The Kootenai-Fisher TMDL Project Area is part of one of the best timber growing regions in Montana. As a result it has been impacted by historical timber harvest activities. Future harvest activities should be conducted by all landowners according to Forestry BMPs for Montana (Montana State University Extension Service, 2001) and the Montana Streamside Management Zone (SMZ) Law (77-5-301 through 307 MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e., within 50 feet of a waterbody), the riparian protection principles behind the law can be applied to numerous land management activities (i.e., timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. The DNRC is responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular Forestry BMP training sessions for private landowners.

The SMZ Law protects against excessive erosion and therefore is appropriate for helping meet sediment load allocations. USFS INFISH Riparian Habitat Conservation Area guidelines provide significant sediment protection as well as protection from elevated thermal loading (i.e., elevated temperature) by providing adequate shade. This guidance improves upon Montana's SMZ law and includes an undisturbed 300 foot buffer on each side of fish bearing streams and 150 foot buffer on each side of non-fish bearing streams with limited exclusions and BMP guidance for timber harvest, roads, grazing, recreation and other human sources (U.S. Department of Agriculture, Forest Service, 1995). The Kootenai National Forest adheres to these guidelines. The Native Fish Habitat Conservation Plan developed by Plum Creek Timber includes a riparian management section that supplements the SMZ riparian buffer rules to help Plum Creek minimizes impacts from timber harvest in riparian areas. It includes specific commitments to leave more trees in locations that provide the maximum benefit, such as channel migration zones and provide for an additional caution area outside of the SMZ.

In addition to the BMPs identified above, effects that timber harvest may have on yearly streamflow levels, such as peak flow, should be considered. Water yield and peak flow increases should be modeled in areas of continued timber harvest and potential effects should be evaluated. Furthermore, increased use, construction, and maintenance of unpaved roads associated with forestry and timber harvest activities should be addressed with appropriate BMPs discussed in **Section 10.5.5**. Finally, noxious weed control should be actively pursued in all harvest areas and along all forest roads.

10.5.3 Riparian Areas, Wetlands, and Floodplains

Healthy and functioning riparian areas, wetlands, and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. The performance of the above named functions is dependent on the connectivity of riparian areas, wetlands, and floodplains to both the stream channel and upland areas. Human activities affecting the quality of these transitional habitats or their connectivity can alter their performance and greatly affect the transport of water, sediments, and contaminants (e.g., channelization, increased stream power, bank erosion, and habitat loss or degradation). Therefore, restoring, maintaining, and protecting riparian areas, wetlands, and floodplains within the watershed should be a priority of TMDL implementation in the Kootenai-Fisher TMDL Project Area.

Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e., plantings) may be necessary in some instances. The primary advantage of riparian and wetland plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property.

Factors influencing the appropriate riparian and wetland restoration would include severity of degradation, site-potential for various species, and availability of local sources for native transplant materials. In general, riparian and wetland plantings would promote establishment of functioning stands of native species. The following recommended restoration measures would allow for stabilization of the soil, decrease sediment delivery to the stream, and increase absorption of nutrients from overland runoff:

- Harvesting and transplanting locally available sod mats with an existing dense root mass provides immediate promotion of bank stability and filtering nutrients and sediments
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity at locations where lower bank shear stresses would be unlikely to cause erosion
- Willow sprigging expedites vegetative recovery, but involves harvest of dormant willow stakes from local sources
- Transplanting mature native shrubs, particularly willows (*Salix* sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading, as well as uptake of nutrients

Note: Before transplanting *Salix* from one location to another it is important to determine the exact species so that we do not propagate the spread of non-native species. There are several non-native willow species that are similar to our native species and commonly present in Montana watersheds.

In addition to the benefits described above, it should be noted that in some cases, wetlands act as areas of shallow subsurface groundwater recharge and/or storage areas. The captured water via wetlands is then generally discharged to the stream later in the season and contributes to the maintenance of base flows and stream temperatures. Restoring ditched or drained wetlands can have a substantial effect on the quantity, temperature, and timing of water returning to a stream, as well as the pollutant filtering capacity that improved riparian and wetlands provide.

10.5.4 Residential/Urban Development

There are multiple sources and pathways of pollution to consider in residential and urban areas. Destruction of riparian areas, pollutants from both functioning and failing septic systems, and stormwater generated from impervious areas and construction sites are discussed below.

10.5.4.1 Riparian Degradation

Residential development adjacent to streams can affect the amount and health of riparian vegetation, the amount of large woody debris available in the stream, and might result in placement of riprap on streambanks (see **Section 10.5.5**). As discussed in the above section on riparian areas, wetlands, and floodplains, substantially degraded riparian areas do not effectively filter pollutants from upland runoff. Riparian areas that have been converted to lawns or small acreage pastures for domestic livestock may suffer from increased contributions of nutrients, sediment, and bacteria, as well as increased summer stream temperatures, increased channel erosion, and greater damage to property from flooding (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b).

Some of these effects are apparent within the Lake Creek watershed, where residential development has caused the erosion of fine-grained sediment from streambanks resulting in sedimentation and degradation of spawning habitat. FWP has recently purchased land for a conservation easement to help reduce residential development within the Lake Creek watershed. For landowners, conservation easements can be a viable alternative to subdividing land and can be facilitated through several organizations such as The Nature Conservancy, the Trust for Public Land, and FWP. Further information on conservation easements and other landowner programs can be obtained from FWP (http://fwp.mt.gov/fishAndWildlife/habitat/wildlife/programs/landownersGuide.html).

DEQ encourages the consideration of adopting local zoning or regulations that protect the functions of floodplains and riparian and wetland areas where future growth may occur. Requirements for protecting native vegetation riparian buffers can be an effective mechanism for maintaining or improving stream health. Local outreach activities to inform new residential property owners of the effects of riparian degradation may also prevent such activities from occurring, including providing information on: appropriate fertilizer application rates to lawns and gardens, regular septic system maintenance, preserving existing riparian vegetation, native vegetation for landscaping, maintaining a buffer to protect riparian and wetland areas, and practices to reduce the amount of stormwater originating from developed property. Montana's Nonpoint Source Management Plan contains suggested BMPs to address the effects of residential and urban development, and also contains an appendix of setback regulations that have been adopted by various cities and counties in Montana (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b). Planning guides and informational publications related to wetlands and native plant species in Montana can be found on DEQ's Wetlands Conservation website at: http://deq.mt.gov/wqinfo/Wetlands/default.mcpx.

10.5.4.2 Septic

There are approximately 585 structures in the Lake Creek watershed that potentially have septic systems. This number is likely to increase with future residential development in the Lake Creek watershed and other watersheds within the Kootenai-Fisher TMDL Project Area. Nutrient loading values for septic systems vary depending on soil type and distance to the nearest stream, but typical values for nitrogen and phosphorous loads from individual septic systems are 30.5 lbs/yr and 6.44 lbs/yr, respectively. However, septic systems should already have minimum design/installation requirements, which should serve as a basic BMP. Older systems should be upgraded and all new systems should meet these minimum requirements.

10.5.4.3 Stormwater

Where precipitation from rain or snowmelt events does not infiltrate soils in urban areas and at construction sites, it drains off the landscape as stormwater, which can carry pollutants into waterways. As the percentage of impervious surfaces (e.g., streets, parking lots, roofs) increases, so does the volume of stormwater and pollutant loads delivered to waterbodies. Although stormwater is not currently identified as a significant source of pollutant contributions for the streams discussed in this document, stormwater management could be a consideration when identifying water quality improvement objectives within the watershed restoration plan. The primary method to control stormwater discharges is the use of BMPs. Additional information can be found in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b). A guide to stormwater BMPs can be found on EPA's National Menu of Stormwater Best Management Practices at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm. The Montana Water Center also has a website dedicated to stormwater control for construction activities: http://stormwater.montana.edu/.

10.5.5 Bank Hardening/Riprap/Revetment/Floodplain Development

The use of riprap or other "hard" approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although it is necessary in some instances, it generally redirects channel energy and exacerbates erosion in other places. Bank armoring should be limited to areas with a demonstrated threat to infrastructure. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit threats to infrastructure by reducing floodplain development through local land use planning initiatives.

Bank stabilization using natural channel design techniques can provide both bank stability and aquatic habitat potential. The primary recommended structures include natural or "natural-like" structures, such as large woody debris jams. These natural arrays can be constructed to emulate historical debris assemblages that were introduced to the channel by the adjacent cottonwood-dominated riparian community types. When used together, woody debris jams and straight log vanes can benefit the stream and fishery by improving bank stability, reducing bank erosion rates, adding protection to fillslopes and/or embankments, reducing near-bank shear stress, and enhancing aquatic habitat and lateral channel margin complexity.

10.5.6 Unpaved Roads and Culverts

Unpaved roads contribute sediment (as well as nutrients and other pollutants) to streams in the Kootenai-Fisher TMDL Project Area. The road sediment reductions provided in this document, and detailed in **Appendix D**, represent an estimation of the sediment load that would remain once additional road BMPs are applied. The main focus of the BMPs used to estimate reduction in loading was to reduce the contributing length to the maximum extent practicable at each crossing. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Road BMPs can be found on the Montana DEQ or DNRC websites and within Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b). Examples include:

- Providing adequate ditch relief up-grade of stream crossings
- Constructing waterbars, where appropriate, and up-grade of stream crossings
- Using rolling dips on downhill grades with an embankment on one side to direct flow to the ditch
- Insloping roads along steep banks with the use of cross slopes and cross culverts
- Outsloping low traffic roads on gently sloping terrain with the use of a cross slope
- Using ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches
- For maintenance, grading materials to the center of the road and avoid removing the toe of the cutslope
- Preventing disturbance to vulnerable slopes
- Using topography to filter sediments; flat, vegetated areas are more effective sediment filters
- Where possible, limiting road access during wet periods when drainage features could be damaged

Undersized and improperly installed and maintained culverts can be a substantial source of sediment to streams, and a barrier to fish and other aquatic organisms. Although there are a lot of factors associated with culvert failure and it is difficult to estimate the true at-risk load, the culvert analysis (**Appendix D**) found that approximately 90% of the culverts pass the discharge of a 25-year storm event. The allocation strategy for culverts is no loading from culverts as a result of being undersized, improperly installed, or inadequately maintained. The culvert assessment included 21 culverts in the watershed, which is a small percentage of the total culverts, and it is recommended that the remaining culverts be assessed so that a priority list may be developed for culvert replacement. As culverts fail, they should be replaced by culverts that pass a 100 year flood on fish bearing streams and at least 25 year events on non-fish bearing streams. Some road crossings may not pose a feasible situation for upgrades to these sizes because of road bed configuration; in those circumstances, the largest size culvert feasible should be used. If funding is available, culverts should be prioritized and replaced prior to failure.

Another consideration for culvert upgrades should be fish and aquatic organism passage. In a coarse assessment of fish passage, 96% of assessed culverts were determined to have a high certainty of not providing juvenile fish passage at all flows; this suggests that a large percentage of culverts in the watershed are barriers to fish passage. Each fish barrier should be assessed individually to determine if it functions as an invasive species and/or native species barrier. These two functions should be weighed against each other to determine if each culvert acting as a fish passage barrier should be mitigated. Montana FWP can aid in determining if a fish passage barrier should be mitigated, and if so, can aid in culvert design.

10.5.7 Mining

The Kootenai-Fisher TMDL Project Area and Montana more broadly, have a legacy of mining which continues today. Mining activities may have impacts that extend beyond increased metal concentrations in the water. Channel alteration, riparian degradation, and runoff and erosion associated with mining can lead to sediment, habitat, nutrient, and temperature impacts as well. The need for further characterization of impairment conditions and loading sources is addressed through the monitoring plan in **Section 11.3**.

A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from historic mines, associated disturbances, and metal refining impacts. Some regulatory programs and approaches that may be applicable to the Kootenai-Fisher TMDL Project Area include:

- The State of Montana Mine Waste Cleanup Bureau's Abandoned Mine Lands (AML) Reclamation Program
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA).
- The federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

More detailed information is included in **Appendix H**.

10.5.7.1 The Surface Mining Control and Reclamation Act (SMCRA)

DEQ's Abandoned Mines Bureau (AMB) is responsible for reclamation of abandoned mines in Montana. The AMB reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA). SMCRA funding is collected as a per ton fee on coal production that is then distributed to states by the federal Office of Surface Mining Reclamation and Enforcement. Funding eligibility is based on land ownership and date of mining disturbance. Eligible abandoned coal mine sites have a priority for reclamation construction funding over eligible non-coal sites. Areas within federal Superfund sites and areas where there is a reclamation obligation under state or federal laws are not eligible for expenditures from the abandoned mine reclamation program. **Table 10-1** lists the priority abandoned mines in the Kootenai-Fisher TMDL Project Area.

Table 10-1. Priority Abandoned Mine Sites in the Kootenai-Fisher TMDL Project Area

Site Name	Receiving Stream	Original AIMSS Ranking Score*
Snowshoe Mine	Snowshoe Creek	69.39
Cherry Creek Millsite	Cherry Creek	100

* AIMSS = Abandoned and Inactive Mines Scoring System

10.5.7.2 Other Historical Mine Remediation Programs

Appendix H provides a summary of mining remediation programs and approaches that can be or may currently be applied within the Kootenai-Fisher TMDL Project Area. The extent that these programs may be necessary will depend on the level of stakeholder involvement and initiative throughout the watersheds with metals impairment causes.

10.6 POTENTIAL FUNDING AND TECHNICAL ASSISTANCE SOURCES

Prioritization and funding of restoration or water quality improvement projects is integral to maintaining restoration activities and monitoring project successes and failures. Several government agencies and also a few non-governmental organizations fund or can provide assistance with watershed or water quality improvement projects or wetlands restoration projects. Below is a brief summary of potential funding sources and organizations to assist with TMDL implementation. **Appendix H** of this document outlines funding sources to assist with mining related TMDL implementation.

10.6.1 Section 319 Nonpoint Source Grant Program

DEQ issues a call for proposals every year to award Section 319 grant funds administered under the federal Clean Water Act. The primary goal of the 319 program is to restore water quality in waterbodies whose beneficial uses are impaired by nonpoint source pollution and whose water quality does not meet state standards. 319 funds are distributed competitively to support the most effective and highest priority projects. In order to receive funding, projects must directly implement a DEQ-accepted watershed restoration plan and funds may either be used for the education and outreach component of the WRP or for implementing restoration projects. The recommended range for 319 funds per project proposal is $10,000 to $30,000 for education and outreach activities and $50,000 to $300,000 for implementation projects. All funding has a 40% cost share requirement, and projects must be administered through a governmental entity such as a conservation district or county, or a nonprofit organization. For information about past grant awards and how to apply, please visit http://deq.mt.gov/wqinfo/nonpoint/319GrantInfo.mcpx.

10.6.2 Future Fisheries Improvement Program

The Future Fisheries grant program is administered by FWP and offers funding for projects that focus on habitat restoration to benefit wild and native fish. Anyone ranging from a landowner or community-based group to a state or local agency is eligible to apply. Applications are reviewed annually in December and June. Projects that may be applicable to the Kootenai-Fisher Project Area include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats. For additional information about the program and how to apply, please visit http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/.

10.6.3 Watershed Planning and Assistance Grants

The DNRC administers Watershed Planning and Assistance Grants to watershed groups that are sponsored by a conservation district. Funding is capped at $10,000 per project and the application cycle is quarterly. The grant focuses on locally developed watershed planning activities; eligible activities include developing a watershed plan, group coordination costs, data collection, and educational activities. For additional information about the program and how to apply, please visit http://dnrc.mt.gov/cardd/LoansGrants/WatershedPlanningAssistance.asp.

Numerous other funding opportunities exist for addressing nonpoint source pollution. Additional information regarding funding opportunities from state agencies is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

10.6.4 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is administered by NRCS and offers financial (i.e., incentive payments and cost-share grants) and technical assistance to farmers and ranchers to help plan and implement conservation practices that improve soil, water, air and other natural resources on their land. The program is based on the concept of balancing agricultural production and forest management with environmental quality, and is also used to help producers meet environmental regulations. EQIP offers contracts with a minimum length of one year after project implementation to a maximum of 10 years. Each county receives an annual EQIP allocation and applications are accepted continually during the year; payments may not exceed $300,000 within a six-year period. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.

10.6.5 Resource Indemnity Trust/Reclamation and Development Grants Program

The Resource Indemnity Trust / Reclamation and Development Grants Program (RIT/RDG) is an annual program administered by DNRC that can provide up to $300,000 to address environmental related issues. This money can be applied to sites included on the DEQ Abandoned Mine Lands (AML) priority list, but of low enough priority where cleanup under AML is uncertain. RIT/RDG program funds can also be used for conducting site assessment/characterization activities such as identifying specific sources of water quality impairment. RIT/RDG projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county. For additional information about the program and how to apply, please visit http://dnrc.mt.gov/cardd/ResourceDevelopment/rdgp/ReclamationDevelopmentGrantsProgram.asp.

10.6.6 Montana Partners for Fish and Wildlife

Montana Partners for Fish and Wildlife is a program under the U.S. Fish & Wildlife Service that assists private landowners to restore wetlands and riparian habitat by offering technical and financial assistance. For additional information about the program and to find your local contact for the Kootenai River watershed, please visit: http://www.fws.gov/mountain-prairie/pfw/montana/.

10.6.7 Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary conservation program administered by the NRCS that offers landowners the means to restore, enhance, and protect wetlands on their property through permanent easements, 30 year easements, or Land Treatment Contracts. The NRCS seeks sites on agricultural land where former wetlands have been drained, altered, or manipulated by man. The landowner must be interested in restoring the wetland and subsequently protecting the restored site. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/programs/easements/wetlands/

10.6.8 Montana Wetland Council

The Montana Wetland Council is an active network of diverse interests that works cooperatively to conserve and restore Montana’s wetland and riparian ecosystems. Please visit their website to find dates and locations of upcoming meetings, wetland program contacts, and additional information on potential grants and funding opportunities: http://deq.mt.gov/wqinfo/wetlands/wetlandscouncil.mcpx.

10.6.9 Montana Natural Heritage Program

The Montana Natural Heritage Program is a valuable resource for restoration and implementation information including maps. Wetlands and riparian areas are one of the 14 themes in the Montana Spatial Data Infrastructure. The Montana Wetland and Riparian Mapping Center (found at: http://mtnhp.org/nwi/) is creating a statewide digital wetland and riparian layer as a resource for management, planning, and restoration efforts.

10.6.10 Montana Aquatic Resources Services, Inc.

Montana Aquatic Resources Services, Inc. (MARS) is a nonprofit organization focused on restoring and protecting Montana’s rivers, streams and wetlands. MARS identifies and implements stream, lake, and wetland restoration projects, collaborating with private landowners, local watershed groups and conservation districts, state and federal agencies, and tribes. For additional information about the program, please visit http://montanaaquaticresources.org/.

11.0 MONITORING STRATEGY AND ADAPTIVE MANAGEMENT

11.1 MONITORING PURPOSE

The monitoring strategies discussed in this section are an important component of watershed restoration, and a requirement of TMDL implementation under the Montana Water Quality Act (MCA 75-5-703(7)), and the foundation of the adaptive management approach. Water quality targets and allocations presented in this document are based on available data at the time of analysis. The scale of the watershed analysis, coupled with constraints on time and resources, often result in necessary compromises that include estimations, extrapolation, and a level of uncertainty in TMDLs. The margin of safety (MOS) (**Section 4.4**) is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities, the amount of reduction of instream pollutants (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate.

The monitoring strategy presented in this section provides a starting point for the development of more detailed planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet the water quality improvement goals outlined in this document. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on funding opportunities and stakeholder priorities for restoration. Once restoration measures have been implemented for a waterbody with an approved TMDL and given time to take effect, DEQ will conduct a formal evaluation of the waterbody's impairment status and whether TMDL targets and water quality standards are being met.

11.2 ADAPTIVE MANAGEMENT AND UNCERTAINTY

In accordance with the Montana Water Quality Act (MCA 75-5-703 (7) and (9)), DEQ is required to assess the waters for which TMDLs have been completed and restoration measures, or best management practices (BMPs), have been applied to determine whether compliance with water quality standards has been attained. This aligns with an adaptive management approach that is incorporated into DEQ's assessment and water quality impairment determination process.

Adaptive management as discussed throughout this document is a systematic approach for improving resource management by learning from management outcomes, and allows for flexible decision making. There is an inherent amount of uncertainty involved in the TMDL process, including: establishing water quality targets, calculating existing pollutant loads and necessary load allocations, and determining effects of BMP implementation. Use of an adaptive management approach based on continued monitoring of project implementation helps manage resource commitments as well as achieve success in meeting the water quality standards and supporting all water quality beneficial uses. This approach further allows for adjustments to restoration goals, TMDLs, and/or allocations, as necessary.

For an in-depth look at the adaptive management approach, view the U.S. Department of the Interior's (DOI) technical guide and description of the process at:

http://www.doi.gov/archive/initiatives/AdaptiveManagement/. DOI includes **Figure 11-1** below in their technical guide as a visual explanation of the cyclic process of adaptive management (Williams et al., 2009).

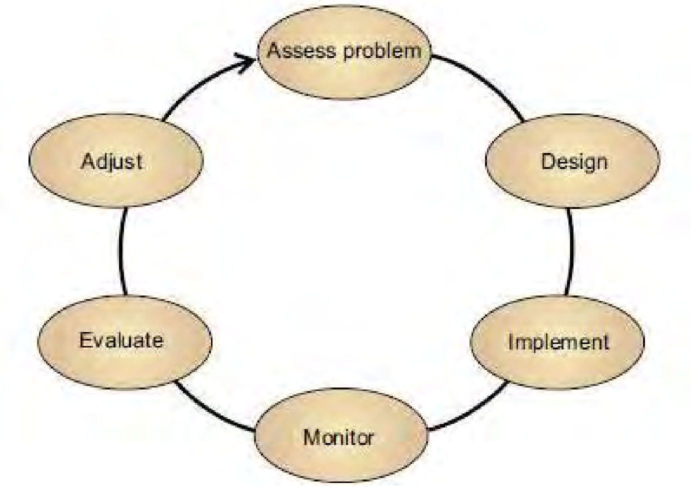

Figure 11-1. Diagram of the adaptive management process

11.3 FUTURE MONITORING GUIDANCE

The objectives for future monitoring in the Kootenai-Fisher TMDL Project Area include:

- Strengthen the spatial understanding of sources for future restoration work, which will also improve source assessment analysis for future TMDL review
- Gather additional data to supplement target analysis, better characterize existing conditions, and improve or refine assumptions made in TMDL development
- Gather consistent information among agencies and watershed groups that is comparable to the established water quality targets and allows for common threads in discussion and analysis
- Expand the understanding of streams throughout the Kootenai-Fisher TMDL Project Area beyond those where TMDL have been developed and address issues
- Track restoration projects as they are implemented and assess their effectiveness

11.3.1 Strengthening Source Assessment

In the Kootenai-Fisher TMDL Project Area, the identification of pollutant sources was conducted largely through tours of the watershed, assessments of aerial photographs, the incorporation of geographic information system information, reviewing and analyzing available data, and the review of published scientific studies. Limited field-verification of the available data was able to be conducted. In many cases, assumptions were made based on known watershed conditions and extrapolated throughout the project area. As a result, the level of detail often does not provide specific areas on which to focus restoration efforts, only broad source categories to reduce pollutant loads from each of the discussed streams and subwatersheds. Strategies for strengthening source assessments for each of the pollutant categories are outlined below.

Sediment

- Field surveys of roads and road crossings to identify specific contributing segments and crossings, their associated loads, and prioritize those road segments/crossings of most concern.

- Reviews of land use practices within the specific subwatersheds of concern to determine where the greatest potential for improvement and likelihood of sediment reduction can occur for the identified major land use categories.
- More thorough examinations of streambank erosion conditions and investigation of related contributing factors for each subwatershed of concern through site visits and subwatershed-scale bank erosion hazard index (BEHI) assessments. Additionally, the development of bank erosion retreat rates specific to the Kootenai-Fisher TMDL Project Area would provide a more accurate quantification of sediment loading from bank erosion. Bank retreat rates can be determined by installing bank pins at different positions on the streambank at several transects across a range of landscape settings and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

Temperature

- Field surveys to better identify and characterize riparian area conditions and potential for improvement
- Identification of possible areas for improvement in shading along major tributaries, particularly in the mid to upper Wolf Creek watershed where past management has degraded riparian vegetation
- Collection of flow measurements at all temperature monitoring locations during the time of data collection
- Investigation of groundwater influence on instream temperatures, and relationships between groundwater availability and water use in the Wolf Creek watershed and the entire Kootenai-Fisher project area
- Assessment of irrigation practices (though limited) and other water use in Wolf Creek watershed and Kootenai-Fisher project area and potential for improvements in water use that would result in increased instream flows
- Use additional collected data to evaluate and refine the temperature targets

Nutrients

- A better understanding of nutrient concentrations in groundwater (as well as the sources) and the spatial variability of groundwater with high nutrient concentrations
- A better understanding of cattle grazing practices and the number of animals grazed in the Kootenai-Fisher TMDL Project Area
- A better understanding of natural background concentrations in Stanley Creek, including a more focused source assessment for Fairway Creek
- A more detailed understanding of nutrient contributions from historical and current mining within the watershed, particularly the Troy Mine tailings impoundment
- A better understanding of septic system contributions to nutrient loads
- A review of land management practices specific to subwatersheds of concern to determine where the greatest potential for improvement can occur for the major land use categories
- Evaluation of didymo in Lake Creek and if it is contributing to elevated AFDM values
- Additional sampling in streams that have limited data

Metals

The level of detail of the source assessment for this project allowed allocations to broad source categories and geographic areas. Therefore, additional monitoring may be helpful to better partition pollutant loading at mine sites with multiple sources. The following is recommended:

- Refinement of the sampling approach and locations at individual mine sites to better partition pollutant loading from discrete sources within the broader mine site. This may require more seasonally stratified sampling or a more detailed field reconnaissance and follow-up sampling to locate stream segments that represent background loading.
- In Big Cherry Creek, the inability to distinguish background aluminum loading from human-caused aluminum loading led to use of a broad composite allocation. Further sampling would allow better delineation of aluminum and other metal sources.
- DEQ recommends additional monitoring of all metals parameters in the upstream sections of Stanley Creek, as there were limited upstream data from above the Troy Mine in Stanley Creek.
- DEQ recommends additional monitoring of all metals parameters in all sections of Lake Creek. Additional monitoring of metals water quality data will yield a better understanding of metals source locations in the watershed.

The descriptions of several of the priority abandoned mines are based on information collected during early 1990s site inventories. Additional site reconnaissance and monitoring of discrete sources is needed to better understand sources of metals loading and develop remediation strategies. The following bulleted items describe source assessment information that could improve our understanding of loading at the priority mine sites.

- A more detailed characterization of mine tailings in the streambanks of Snowshoe Creek and their impacts on water quality.
- A more detailed surface water monitoring regime directed at defining sources of metals pollution from the Cherry Creek Mill site.

11.3.2 Increasing Available Data

While the Kootenai-Fisher TMDL Project Area has undergone significant remediation and restoration activities, data are still often limited depending on the stream and pollutant of interest. Infrequent sampling events at a small number of sampling sites may provide some indication of overall water quality and habitat condition. However, regularly scheduled sampling at consistent locations, under a variety of seasonal conditions is the best way to assess overall stream health and monitor change.

Sediment

For sediment investigation in the Kootenai-Fisher TMDL Project Area, each of the streams of interest was stratified into unique reaches based on physical characteristics and human-caused influences. A total of 15 sites were sampled throughout the watershed, which is only a small percentage of the total number of stratified reaches, and even less on a stream by stream basis. Sampling additional monitoring locations to represent some of the various reach categories that occur would provide additional data to assess existing conditions. It would also provide more specific information on a per-stream basis and for the Kootenai-Fisher TMDL Project Area as a whole, and can be used for reach by reach comparisons and assessing potential influencing factors and resultant outcomes that exist throughout the project area.

Temperature

Temperature investigation for Wolf Creek included 12 data loggers that were deployed throughout the stream. Increasing the number of data logger locations and the number of years of data, including collection of associated flow data, would improve our understanding of instream temperature changes and better identify influencing factors on those changes. Collecting additional stream temperature data in sections with the most significant temperature changes and/or largest spatial gaps between loggers will also help refine the characterization of temperature conditions in Wolf Creek. In addition, since shade is the major focus of the allocations, a more detailed assessment of existing vegetation, limitation, and identification of areas for passive and active restoration of riparian vegetation on Wolf Creek and major tributaries is recommended.

Nutrients

Water quality sampling locations for nutrients were distributed spatially along each stream in order to best delineate nutrient sources. Over multiple sample seasons, sampling locations were refined to better quantify loading sources to the impaired waterbodies. However, due to the limited amount of surface flow in Raven Creek, sampling locations were restricted to the lower section of the stream. Available data indicate borderline impairment for Raven Creek, and additional data collection is recommended to strengthen the impairment determination. To better evaluate nutrient loading, source refinement will continue to be necessary on all streams with nutrient TMDLs and those that have not yet been assessed in the project area. With changing land uses and/or new permitted discharges to surface waters, it will be important to continually assess nutrient sources in a watershed.

Metals

Additional monitoring may be helpful to better partition pollutant loading at mine sites with multiple sources, such as those having discrete adit discharges versus more diffuse runoff from mine waste accumulations. The needed refinements may require more seasonally stratified sampling or a more detailed field reconnaissance and follow-up sampling to better locate stream segments representing background loading. Additional data collection is recommended for:

- The Snowshoe Mine section of Snowshoe Creek that was restored between 2007 and 2010. Future monitoring should be planned to track arsenic, cadmium, lead and zinc concentrations in Snowshoe Creek as well as antimony, copper, mercury and silver concentrations, with attention to any soil and land conservation BMPs that may be implemented to meet the sediment TMDL .
- Copper concentrations in Lake Creek. The copper impairment determination was based on the detected concentration exceeding the twice the acute aquatic life standard. Future reassessment based on a larger sample population may conclude that copper is no longer an impairment cause to Lake Creek.
- All metals parameters that were listed for impairment in the upstream sections of Stanley Creek. There was limited upstream data from above the Troy Mine in Stanley Creek.

Table 11-1 lists the waterbodies, pollutants, and flow conditions where additional data is needed.

Table 11-1. Waterbodies, metal pollutants, and flow conditions for which additional data is needed

Stream Segment	Pollutant(s)	Flow Condition
Snowshoe Creek	Arsenic	High and Low
	Cadmium	High and Low
	Lead	High and Low
	Zinc	High and Low
Stanley Creek	Cadmium	High and Low
	Copper	High and Low
	Lead	High and Low
	Zinc	High and Low
Lake Creek	Copper	High and Low

For the pollutant-waterbody combinations in **Table 11-1**, follow up monitoring should focus on defining the contribution from sources in Snowshoe and Lake Creeks, as well as defining background water quality conditions in Stanley Creek. As this information becomes available, TMDL allocations may be modified to include load allocations to background sources, as opposed to the current composite wasteload allocations.

11.3.3 Consistent Data Collection and Methodologies

Data has been collected throughout the Kootenai-Fisher TMDL Project Area for many years and by many different agencies and entities; however, the type and quality of information is often variable. Wherever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals.

DEQ is the lead agency for developing and conducting impairment status monitoring; however, other agencies or entities may work closely with DEQ to provide compatible data. Water quality impairment determinations are made by DEQ, but data collected by other sources can be used in the impairment determination process. The information in this section provides general guidance for future impairment status monitoring and effectiveness tracking. Future monitoring efforts should consult DEQ on updated monitoring protocols. Improved communication between agencies and stakeholders will further improve accurate and efficient data collection.

It is important to note that monitoring recommendations are based on TMDL related efforts to protect water quality beneficial uses in a manner consistent with Montana’s water quality standards. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, state, and federal laws. For example, reclamation of a mining related source of metals under CERCLA and CECRA typically requires source-specific sampling requirements, which cannot be defined at this time, to determine the extent of and the risk posed by contamination, and to evaluate the success of specific remedial actions.

Sediment

Sediment and habitat assessment protocols consistent with the DEQ field methodologies that serve as the basis for sediment targets and assessments within this TMDL document should be conducted whenever possible. Current protocols are identified within Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (Montana Department of Environmental Quality, 2012b). It is acknowledged that various agencies and entities have differing objectives, as well as time and resources available to achieve those objectives. However, when possible, when collecting sediment and habitat data in the Kootenai-Fisher TMDL Project Area it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:

- Riffle Cross Section: using Rosgen methodology
- Riffle Pebble Count: using Wolman Pebble Count methodology
- Pool Assessment: count and residual pool depth measurements

Additional information will undoubtedly be useful and assist DEQ with TMDL effectiveness monitoring in the future. Macroinvertebrate studies, McNeil core sediment samples, and fish population surveys and redd counts are examples of additional useful information used in impairment status monitoring and TMDL effectiveness monitoring that were not developed as targets but were reviewed where available during the development of these TMDLs.

Temperature

Consistency in temperature data collection is not as significant for what is collected as much as how and where it is collected. Data loggers should be deployed at the same locations through the years to accurately represent the site-specific conditions over time, and recorded temperatures should at a minimum represent the hottest part of the summer when aquatic life is most sensitive to warmer temperatures. Data loggers should be deployed in the same manner at each location and during each sampling event, and follow a consistent process for calibration and installation. Any modeling that is used should refer to previous modeling efforts (such as the QUAL2K analysis used in this document) for consistency in model development to ensure comparability. In addition, flow measurements should also be conducted using consistent locations and methodology.

Nutrients

For those watershed groups and/or government agencies that monitor water quality, it is recommended that the same analytical procedures and reporting limits are used so that water quality data may be compared to TMDL targets (**Table 11-2**). In addition, stream discharge should be measured at time of sampling.

Table 11-2. DEQ Nutrient Monitoring Parameter Requirements

Parameter*	Preferred method	Alternate method	Required reporting limit (ppb)	Holding time (days)	Bottle	Preservative
Total Persulfate Nitrogen (TPN)	A4500-NC	A4500-N B	40	28	250mL HDPE	≤6°C (7d HT); Freeze (28d HT)
Total Phosphorus as P	EPA-365.1	A4500-P F	3			H2S04, ≤6°C of Freeze
Nitrate-Nitrite as N	EPA-353.2	A4500-N03 F	10			

*Preferred analytical methods and required reporting limits may change in the future (e.g., become more stringent); consult with DEQ prior to any monitoring effort in order to ensure you use the most current methods.
HT = Holding Time

Metals

Metals monitoring should include analysis of a suite of total recoverable metals (e.g., As, Cu, Cd, Pb, Zn), sediment samples, hardness, pH, discharge, and total suspended solids (TSS). **Table 11-3** identifies the current DEQ metals sampling methodologies and reporting limits for the standard metals suite (water and sediment).

Table 11-3. DEQ Metals Monitoring Parameter Requirements

Parameter*	Preferred Method	Alternate Method	Req. Report Limit ug/L	Holding Time Days	Bottle	Preservative
Water Sample - Physical Parameters and Calculated Results						
Total Hardness as $CaCO_3$	A2340 B (Calc)		1000			
Total Suspended Solids	A2540D		4000	7	1000 ml HDPE/500 mlHDPE	≤6oC
Water Sample - Dissolved Metals (0.45 um filtered)						
Aluminum	EPA 200.7	EPA 200.8	9	180	250 ml HDPE	Filt 0.45 um, HNO_3
Water Sample - Total Recoverable Metals						
Total Recoverable Metals Digestion	EPA 200.2	APHA3030F (b)	N/A	180	500 ml HDPE/ 250 ml HDPE	HNO_3
Arsenic	EPA 200.8		1			
Cadmium	EPA 200.8		0.03			
Calcium	EPA 200.7		1000			
Chromium	EPA 200.8	EPA 200.7	1			
Copper	EPA 200.8	EPA 200.7	1			
Iron	EPA 200.7		20			
Lead	EPA 200.8		0.3			
Magnesium	EPA 200.7		1000			
Potassium	EPA 200.7		1000			
Selenium	EPA 200.8		1			
Silver	EPA 200.8	EPA 200.7/200.9	0.2			
Sodium	EPA 200.7		1000			
Zinc	EPA 200.7	EPA 200.8	8			
Antimony	EPA 200.8		0.5			
Barium	EPA 200.7	EPA 200.8	3			
Beryllium	EPA 200.7	EPA 200.8	0.8			
Boron	EPA 200.7	EPA 200.8	10			
Manganese	EPA 200.7	EPA 200.8	5			
Nickel	EPA 200.7	EPA 200.8	2			
Thallium	EPA 200.8		0.2			
Uranium, Natural	EPA 200.8		0.2			
Parameter	**Preferred Method**	**Alternate Method**	**Req. Report Limit mg/kg (dry weight)**	**Holding Time Days**	**Bottle**	**Preservative**
Sediment Sample - Total Recoverable Metals						
Total Recoverable Metals Digestion	EPA 200.2		N/A	180	2000 ml HDPE Widemouth	
Arsenic	EPA 200.8	EPA 200.9	1			
Cadmium	EPA 200.8	EPA 200.9	0.2			
Chromium	EPA 200.8	EPA 200.7	9			
Copper	EPA 200.8	EPA 200.7	15			
Iron	EPA 200.7	EPA 200.7	10			
Lead	EPA 200.8	EPA 200.9	5			
Zinc	EPA 200.7	EPA 200.7	20			

Table 11-3. DEQ Metals Monitoring Parameter Requirements

Parameter*	Preferred Method	Alternate Method	Req. Report Limit ug/L	Holding Time Days	Bottle	Preservative
Sediment Sample - Total Metals						
Mercury	EPA 7471B		0.05	28	2000 ml HDPE Widemouth	

*Preferred analytical methods and required reporting limits may change in the future (e.g., become more stringent); consult with DEQ prior to any monitoring effort in order to ensure you use the most current methods

11.3.4 Effectiveness Monitoring for Restoration Activities

As restoration activities are implemented, monitoring is valuable to determine if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. Monitoring can help attribute water quality improvements to restoration activities and ensure that restoration activities are functioning effectively. Restoration projects will often require additional maintenance after initial implementation to ensure functionality. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is often also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

Due to the natural high variability in water quality conditions, trends in water quality are difficult to define and even more difficult to relate directly to restoration or other changes in management. Improvements in water quality or aquatic habitat from restoration activities will most likely be evident in fine sediment deposition and channel substrate embeddedness, changes in channel cumulative width/depths, improvements in bank stability and riparian habitat, increases in instream flow, and changes in communities and distribution of fish and other bio-indicators. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budget and time constraints.

As restoration activities begin throughout the project area, pre and post monitoring to understand the change that follows implementation will be necessary to track the effectiveness of specific projects. Monitoring activities should be selected such that they directly investigate those subjects that the project is intended to effect, and when possible, linked to targets and allocations in the TMDL. For example, as bank erosion is addressed, pre and post bank erosion hazard index (BEHI) analysis on the subject banks will be valuable to understand the extent of improvement and the amount of sediment reduced.

11.3.5 Watershed Wide Analyses

Recommendations for monitoring in the Kootenai-Fisher TMDL Project Area should not be confined to only those streams addressed within this document. The water quality targets presented in this document are applicable to all streams in the watershed, and the absence of a stream from the state's impaired waters list does not necessarily imply that the stream fully supports all beneficial uses. Furthermore, as conditions change over time and land management evolves, consistent data collection methods throughout the watershed will allow resource professionals to identify problems as they occur, and to track improvements over time.

12.0 STAKEHOLDER AND PUBLIC PARTICIPATION

Stakeholder and public involvement is a component of TMDL planning supported by EPA guidelines and required by Montana state law (MCA 75-5-703, 75-5-704) which directs DEQ to consult with watershed advisory groups and local conservation districts during the TMDL development process. Technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process in the Kootenai-Fisher TMDL Project Area.

12.1 PARTICIPANTS AND ROLES

Throughout completion of the Kootenai-Fisher TMDL Project Area TMDLs, DEQ worked to keep stakeholders apprised of project status and solicited input from a TMDL advisory group. A description of the participants in the development of the TMDLs in the Kootenai-Fisher TMDL Project Area and their roles is contained below.

Montana Department of Environmental Quality
Montana state law (MCA 75-5-703) directs DEQ to develop all necessary TMDLs. DEQ has provided resources toward completion of these TMDLs in terms of staff, funding, internal planning, data collection, technical assessments, document development, and stakeholder communication and coordination. DEQ has worked with other state and federal agencies to gather data and conduct technical assessments. DEQ has also partnered with watershed organizations to collect data and coordinate local outreach activities for this project.

United States Environmental Protection Agency
EPA is the federal agency responsible for administering and coordinating requirements of the Clean Water Act (CWA). Section 303(d) of the CWA directs states to develop TMDLs (see **Section 1.1**), and EPA has developed guidance and programs to assist states in that regard. EPA has provided funding and technical assistance to Montana's overall TMDL program and is responsible for final TMDL approval. Additionally, partial project management was provided by the EPA Regional Office in Helena, MT.

Conservation Districts
The majority of the Kootenai-Fisher TMDL Project Area falls within Lincoln County, and a very small portion in Flathead County. DEQ provided both the Lincoln Conservation District and Flathead Conservation District with consultation opportunity during development of TMDLs. This included opportunities to provide comment during the various stages of TMDL development, and an opportunity for participation in the advisory group discussed below.

TMDL Advisory Group
The Kootenai-Fisher TMDL Advisory Group consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Kootenai-Fisher TMDL Project Area, and also representatives of applicable interest groups. All members were solicited to participate in an advisory capacity per Montana state law (75-5-703 and 704). DEQ requested participation from the interest groups defined in MCA 75-5-704 and included municipalities and county representatives; livestock-oriented and farming-oriented agriculture representatives; timber and mining industry representatives; watershed groups; state and federal land management agencies, tribal representatives; and representatives of fishing-related business, recreation, and tourism interests. The advisory group also

included additional stakeholders with an interest in maintaining and improving water quality and riparian resources.

Advisory group involvement was voluntary and the level of involvement was at the discretion of the individual members. Members had the opportunity to provide comment and review of technical TMDL assessments and reports and to attend meetings organized by DEQ for the purpose of soliciting feedback on project planning. Typically, draft documents were released to the advisory group for review under a limited timeframe, and their comments were then compiled and evaluated. Final technical decisions regarding document modifications resided with DEQ.

Communications with the group members was typically conducted through e-mail and draft documents were made available through DEQ's wiki for TMDL projects (http://montanatmdlflathead.pbworks.com). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including opportunity for review of the draft TMDL document prior to the public comment period.

12.2 RESPONSE TO PUBLIC COMMENTS

Upon completion of a draft TMDL document, DEQ issues a press release and enters into a public comment period. During this timeframe, the draft TMDL document is made available for general public comment; DEQ then addresses and responds to all formal public comments.

The public review period for the draft Kootenai-Fisher TMDL document was initiated on February 3, 2014 and ended on March 4, 2014. During this timeframe, a public meeting was held in Libby, MT on February 13, 2014. At the meeting, DEQ and EPA project team members provided an overview of the TMDLs for metals, nutrients, sediment, and temperature in the Kootenai-Fisher project area, made copies of the document available, and solicited input and comment on the document. Both the public comment period and public meeting were announced in a February 3, 2014 press release from DEQ which was published on DEQ's website and distributed to multiple media outlets across Montana. A public notice advertising the public comment period and public meeting was published in the following newspapers: Daily Inter Lake, Missoulian, Western News, and the Kootenai Valley Record. Additionally, the announcement was distributed to the Kootenai-Fisher TMDL Watershed Advisory Group.

DEQ received public comments from multiple entities during the public comment period. **Appendix I** contains excerpts and summaries of the comments, along with DEQ and EPA's responses (joint comment responses were prepared with the EPA Region 8 Montana Office). Original comment letters and submissions are held on file at DEQ and may be viewed upon request.

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